EARTH ECONOMICS

Louisiana NDRC BCA

1. General BCA Narrative Description

1.1. Summary of BCA

The State of Louisiana has prepared/submitted a Phase II application for specific project funding under the U.S. Department of Housing and Urban Development Natural Disaster Resilience Competition (HUD-NDRC) program. This document serves as the Benefit Cost Analysis (BCA) portion of the application, as required under the HUD-NDRC Notice of Funding Announcement (NOFA).

1.1.1. Process for preparing BCA

Royal Engineers & Consultants, LLC and Earth Economics (Royal/EE) provided the State of Louisiana with the planning and execution of the BCA as required for the NDRC Phase II application. Earth Economics has established national expertise in the development and application of natural capital accounting and BCA. Earth Economics was identified by HUD as subject matter experts (SME) on BCA for the NRDC NOFA application.

2. BCA Project: Living Mitigation

2.1. Project Description

The overall goal of the Terrebonne Living Mitigation Project is to provide sustainable flood risk management alternatives that protect the public and reduce flood damages in Terrebonne Parish using living mitigation, or green infrastructure, techniques. Accomplishing this goal requires reduction of future storm surge energy in coastal marshlands south of Houma, the southernmost metropolitan area of Terrebonne Parish that is the most susceptible to storm surge hazards. The proposed approach for reducing storm surge height is to increase the presence of woody vegetation along shorelines, terraces, embankments, and marshland fringes. This will be accomplished by elevating shallow bottom sediments to create low terraces (1-2 feet above sea level) patterned to maximize sediment deposition, maintain water flow, and minimize erosion. Over time, these terraces will convert shallow water to marshlands through soil deposition and natural propagation of terrace vegetation. The combination of terrace structure, increased vegetation, and expanded marshland will reduce storm surge forces and afford Houma and area infrastructure a measure of protection from natural disasters.

2.2. Overview of Benefit-Cost Analysis

Table 1 provides an overview of the BCA for the Living Mitigation project.

Table 1. Overview of Benefit-Cost Analysis

Value Category	Time Period (years)	Annual Benefit Value	Total Cost Value	Present Value Benefits (7%)	Present Value Costs (7%)	Present Value Benefits (3%)	Present Value Costs (3%)
Lifecycle Cost	1.67		$10,400,000		$10,127,850		$10,278,835
Resilience	100	$1,493,244		$22,798,996		$48,600,422	
Environmental Value	100	$1,494,300		$22,815,119		$48,634,792	
Economic Revitalization	1.67	$8,099,804		$8,099,804		$8,099,804	

			Total	**$54,049,379**	**$10,127,850**	**$64,449,379**	**$10,278,835**

Discount Rate	**7%**	**3%**
Benefit/Cost Ratio	5.34	6.27
Net Present Value	$43,921,529	$54,170,544

2.3. Overview of Living Mitigation Project BCA

The BCA of the Living Mitigation project is organized in the following manner:

1. Description of the current environmental conditions
2. Description of the proposed project
3. Risks if the project is not implemented
4. Summary of costs and benefits
5. Risks of ongoing benefits
6. Challenges of implementation

2.4. Current situation and problem to be solved

The proposed site is part of the Terrebonne Bay drainage basin in the Mississippi River Deltaic Plain. This area is prone to high rates of subsidence due to the compaction of Holocene alluvial sediments and movements of nearby faults. With the additive effects of eustatic sea level rise, nutria herbivory, and hydrologic modifications due to canal and embankment alterations in the landscape, this area has some of the highest rates of coastal land loss in the world. The project design is intended to halt and reverse sedimentation while also providing storm protection, habitat, and other ecosystem service benefits.

2.4.1. What are environmental conditions in your area?

Historically, the region was covered in salt meadow cordgrass, marsh elder, black mangrove, and other vegetation types. Black mangrove has persisted in the intertidal marsh and is a valuable component of the ecosystem. Development patterns throughout the Louisiana Delta have resulted in the removal of these marshes. Loss of black mangrove has significantly reduced this critical moderator of wave energy and eliminated important nesting habitat for birds, including the pelican.

2.4.2. How do trends in land-use, housing development and affordability, and employment impact disaster recovery/vulnerability to identified risks

2.5. Proposal Description

The Terrebonne Parish Living Mitigation Project proposes to mitigate future storm surges and related hazards in Terrebonne Parish by increasing woody vegetation along shorelines, terraces, embankments, and marshland fringes. This will be accomplished by creating a system of low terraces to maximize soil deposition, maintain water flow, and minimize erosion. These terraces will then be planted with soil-stabilizing native plants which will naturally propagate into newly stabilized marshland areas. These wetland terraces are being developed as a part of a larger set of projects to protect and restore the immediate area's infrastructure and residential neighborhoods. They are intended to directly provide wave attenuation to reduce damage from surge during storms. Shrubs and trees planted on these terraces will also lower wave action on adjacent open waters.

The proposal design was requested by Terrebonne Parish under the Louisiana Silver Jackets Program, which provides opportunities for communities to work with all appropriate State and Federal agencies to develop a comprehensive flood risk management program to achieve community goals and address flood risk management priorities.

2.5.1. Key objectives

The primary objective of the Terrebonne Living Mitigation Project is to build sustainable flood risk management capacity to protect the public and reduce flood damages in Terrebonne Parish. The project focuses specifically on reduction of future storm surge energy in coastal marshlands south of Houma. Enhanced protection will be created by constructing a system of low terraces, designed to increase the area of interior marshlands and increase the presence of woody vegetation along shorelines, terraces, embankments, and marshland fringes.

2.5.2. Main components of proposal plan

Rather than constructing structural barriers to attempt to fully block storm surge advancement, this project proposes to restore coastal wetlands which naturally reduce storm surge energy and protect coastal communities and infrastructure. Over time, coastal erosion has transformed wetlands into shallow open water areas unsuitable for vegetation and thus, incapable of reducing storm surge energy. To reverse this process and provide a buffer, surface sediments must be elevated to create low terraces (1-2 feet about sea level), an environmental more suited for the reestablishment of wetland vegetation.

Terraces are soil ridges produced from on-site sediments and planted with native marsh vegetation (typically, grasses and woody shrubs). Terrace elevations are typically built one foot above sea level for grasses, while woody shrubs require greater elevations (e.g. two feet above sea level). The terraces for the Living Mitigation project will be patterned to maximize intertidal edge, minimize fetch between ridges, and maintain water flow in and out of terrace-protected areas. Such conditions are conducive to sediment deposition between terraces; along with the natural propagation of terrace vegetation, these protected shallow waters will ultimately transform into restored marsh habitat.

Storm surge energy is primarily reduced due to vertical deflection of the intermittent terraces design and newly established vegetation. Emerging marsh habitat will further reduce storm surge energy in a similar manner. The Living Mitigation project will ultimately create an estimated 300 acres of marshlands.

2.5.3. Timeline for completion

The Living Mitigation project is projected to be completed within an 18 month timeline. Table 2 below shows the project timeline per task.

Table 2: Project Timeline

Task	MO1	MO2	MO3	MO4	MO5	MO6	MO7	MO8	MO9	MO10	MO11	MO12	MO13	MO14	MO15	MO16	MO17	MO18
Contractor Quality Control	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Construction Survey/Layout	X			X			X			X			X			X		
Mobilization		X																

Terrace Construction		X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Vegetative Planting				X	X		X	X		X	X		X	X		X	X	
Demobilization																		X
Total Construction Schedule	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

2.5.4. Estimated useful life of proposal

The present generation receives a relatively small amount of the total value provided by these services. If a complete conservation of ecosystems is achieved in the present – meaning no further decline of ecological functions – future generations will reap huge economic benefits from healthy functioning ecosystems.

2.5.5. Alternative discount rates (in addition to 7% base-case discount rate)

One central methodological question is that of the discount factor. Discounting is designed to reflect the following:

1. Pure time preference of money: This is the value that people put on something for use now, as opposed to the value they assign for that use or income at a later date.
2. Opportunity cost of investment: A dollar in one year's time has a present value of less than a dollar today, because a dollar today can be invested for a future positive return.
3. Depreciation: Built assets such as roads, bridges, and levees deteriorate and lose value due to wear and tear. Eventually, they must be replaced.

Discounting has limitations when applied to natural capital, or ecosystem service value, however. Using a discount rate assumes that the benefits humans reap in the present are more valuable than the benefits provided to future generations, or even to this generation just a few years into the future. Therefore, it is generally recommended that natural capital assets be treated with lower discount rates (resulting in more future value being accounted for) than built capital assets because they are public goods that provide public benefits. The objective is to maximize social welfare, implying an intergenerational equity principle that calls for future generations to have a productive base at least as productive as the one we have in the present. Natural capital is often irreplaceable and relatively scarce compared to other types of capital and hence has a higher opportunity cost. Current externalities, risks, and uncertainties in markets make today's observed consumption sub-optimal and hence observed interest rates or time preferences sub-optimal as well. Incorporating these market imperfections can make the case for using discount rates for environmental services that are close to zero.[1,2]

Given the above mentioned considerations regarding the appropriate discount rate when applied to natural capital, a three percent discount rate is used in the benefit derivation in Section 1.5 below.

2.6. Risks if proposal is not implemented

Given the existing environmental conditions described in Section 1.2.2, land loss will persist if this proposal is not implemented. Continued land loss will threaten nearby communities and further degrade environmental conditions in the region.

2.6.1. *Additive impacts/benefits (of multiple project components) that will not be realized is not implemented*

In addition to the ecosystem service values demonstrated in Section 2.7.3 below, multiple co-benefits will also remain unrealized if the project is not implemented. Coastal land loss has already led to major community impacts, such as mandatory community relocation and the destabilization that comes along with relocating an entire community.[3] Construction of new wetlands can keep coastal land loss at bay and provide benefits such as increased recreation and fishing opportunities for nearby communities.[4] Taking advantage of these recreational opportunities can provide health benefits and promote social cohesion among those that participate.[5,6]

2.7. Categories of Costs and Benefits

Table 3 shows the summary of costs and benefits for each of the five HUD categories: lifecycle costs, resiliency value, environmental value, social value, and economic revitalization. Each category is described qualitatively, quantitatively, and with monetized benefits. Each category is then described in detail in subsequent sections, followed by a description of the methodology used to assess the value of this project.

Table 3. Summary of Costs and Benefits by Category

Costs and Benefits by category	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	**Monetized effect (if applicable)**
Life cycle costs			
Project Costs	The estimated costs associated with a full implementation of the project over the life cycle of the project.	A total estimated cost was found by estimating the costs of the different project components (terrace construction, mobilization and demobilization, construction survey/layout, quality control, PM oversight and vegetative planting). The costs associated with these different project components were combined to calculate the total project cost estimate.	-10,400,000
Resiliency Value			

One row for each effect	The creation of coastal wetlands provides resiliency to inland communities. Resiliency provides a critical service due to the high coastal erosion and frequency of hurricanes in the region.	A value of disaster risk reduction from wetlands per acre per year was calculated. An estimated 300 acres of wetlands is to be created. Providing an estimate of the annual flow of benefits.	+$ 1,493,244 Risk Reduction Value per Year
Environmental Value			
Ecosystem Service Value	Restoring the marshlands preserves ecosystem services, which are the functions of an ecosystem that provide benefits to humans. An accurate assessment of this project's full value should include ecosystem service values.	A publication of the Millennium Ecosystem Assessment (MEA) classifies ecosystem goods and services into broader categories reflecting specific human impacts. Five categories were used for this section, and Benefit Transfer Methodology was used to provide an estimate for the total annual ecosystem value.	+$ 1,494,300 Total Ecosystem Value per Year
Social Value			
Multiple	Social benefits from the restoration of the marsh will be realized, but not monetized. Benefits from restored fishing and outdoor activities will influence general quality of life. Additional benefits realized come from the value the marsh provides as a storm buffer, thereby lessening the negative social impacts of hurricanes.	For this project, it will not be possible to quantify the social value realized. This is due to a lack of biophysical data and predictive models able to quantify in terms of non-economic measures.	$
Economic Revitalization			

Economic Impact	The restoration of the marsh provides a positive economic impact due to business stabilization as well as income realized from increased storm protection and opportunities for fishing and shell fishing.	An economic assessment of the construction of the marsh was conducted using IMPLAN by placing the life cycle costs values above into the related sectors in IMPLAN. This provides a quantitative "value added" that represents how much economic activity will occur as a result of the costs associated with the construction of the wetland. This amount of "value added" and tax collections were combined to determine the total value of economic revitalization.	**Value Added:** $8,099,803 Employee Comp: $6,425,032 Proprietor Income: $182,624 Other Property Income: $1,156,686 Taxes: $335,460

2.7.1. Lifecycle costs:

Table 4 includes the costs associated with the full implementation of the project over 1.67 year lifetime of the project.

Table 4. Project Costs

Project Component	**Portion (%)**	**Cost**
Terrace Construction	77.5	$8,060,000
Mobilization and Demobilization	1.5	$156,000
Construction Survey/Layout - mark perimeter marking	3.0	$312,000
Quality Control (contractor performance standards)	4.0	$416,000
PM Oversight/QA	4.0	$416,000
Vegetative Planting	10.0	$1,040,000
	100.0	
TPC Estimate		**$10,400,000**

2.7.2. Resiliency value

Coastal wetlands protect inland communities from storms. The creation of wetlands in this project will enable local and regional communities to become more resilient to storms in the future. Wetlands absorb storm energy by decreasing the area of open water for wind to form waves, increasing the drag on water motion with vegetation buffers, and directly absorbing wave energy.[7] The type and density of vegetation and the configuration of the wetland across the coastal landscape significantly affect the storm buffering potential of the wetland. Denser vegetation and higher bed elevation, for instance, can further increase the storm buffering services provided by wetlands.[8]

The high rate of coastal erosion in South Houma combined with its highly hurricane-prone location in Terrebonne Parrish makes storm buffering a critical service to assess in the context of coastal restoration. Hurricanes Katrina and Rita, for example, inflicted over $200 billion in property damages. The combined effects of these two hurricanes damaged over 150 miles of levees and wrecked 360,000 homes, 504 schools, 97 hospitals, 570,000 cars, and 70,000 boats.[9] There was no clear measure of suffering, yet it included increased suicides due to the effects of relocation, job losses, and other harm to individuals, families, communities and the region. This restoration project will mitigate the risk of damages from both large and small storms in the region.

This project would protect the utilities infrastructure, roads, levees, and residences. The sewerage treatment plant and the landfill lie immediately to the north of the project. Failure of existing levees near these structures from wave action would create significant fouling of the marsh and lake as well as the businesses and residences along Highway 57 to the west and Highway 56 to the east. Wind and surge energy could also reach the Houma-Terrebonne Airport and Industrial park to the northwest of the project, or even beyond to undermine the East Houma Surge Levee (raised Thompson Road) which protects a repetitive loss area that encompasses Roberta Grove and Senator Circle.

In the absence of storm surge models that correspond to the scenarios being studied, this analysis will employ a benefit transfer method that draws on a study by Costanza et al. (2008) to predict damages from hurricane vulnerability in Louisiana.[10] More information is provided in the annotated bibliography in Appendix B. The benefit transfer method is a common substitute for original research in the absence of resources and time to run locally tailored or scenario-specific models. All studies used in this assessment were specific to the Louisiana Delta and follow best-use guidelines of the benefit transfer method. Details on this methodology are provided in Appendix A.

Table 5. Value of Disaster Risk Reduction from Wetlands per Acre per Year

Ecosystem Service	Low	High	Average	Studies Used
Disaster Risk Reduction	$3,874.64	$6,080.32	$4,977.48	Costanza, R. et al. (2008)[11]

An estimated 300 acres of marsh will be created under the living mitigation project. Table 6 shows the total value of disaster risk reduction that will be provided by the restored marshlands across all 300 acres.

Table 6. Total Value per Year Disaster Risk Reduction

Total Average Disaster Risk Reduction Value per Acre per Year	Total Restored Acres	Total Disaster Risk Reduction Value per Year
$4,977.48	300	$1,493,244

Disaster risk reduction provides an estimate of the “yearly income”, or the annual flow of benefits, of the marshlands. This would be like the value of yearly rent for a house. Considering this value across time enables the appraisal of the full value of an asset (like the appraised value of a house). The net present value is a critical measure of the overall magnitude of any economic asset.

If maintained and left unthreatened, marsh wetlands will provide disaster protection value in perpetuity. In order to arrive at an asset value of the restored wetlands from the Living Mitigation project, the value was considered over 100 years. In Table 7 below, this value was calculated using both a three percent and a seven percent discount rate. Justification for the use of the three percent discount rate was provided in Section 1.3.7 above.

Table 7. Present Value of Disaster Risk Reduction Value of 300-Acre Marsh Restoration with 3% and 7% Discount Rates

	Disaster Risk Reduction of 300-Acre Marsh Restoration	PV 100 Years (3%)	PV 100 Years (7%)
Total Value	$1,493,244	$48,600,422	$22,798,996
Per Acre Value	$4,977	$162,001	$75,997

2.7.3. Environmental value

2.7.3.1. Description

The environmental value of the living mitigation project is assessed in terms of the ecosystem services provided by the restoration efforts of this project. Restoration of coastal wetlands creates a suite of ecosystem services, including buffer against storm surge energy, creation of habitat, increased opportunities for recreation, enhancement of aesthetic value to property and public spaces, creation of wastewater buffer treatment strip, and many other ecosystem services.

Considerable progress has been made in systematically linking ecosystem functions with human well-being. Ecosystems perform many functions, but the term "ecosystem services" specifically refers to functions that provide human benefits. Ecosystem services are "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." Many gains and losses from a changing environmental landscape can be classified into ecosystem service categories. A few prime examples of these services are potable water, food, raw materials, flood protection and recreation. A key advancement in this conceptualization of human dependence on nature was the publication of the Millennium Ecosystem Assessment (MEA), which classified ecosystem goods and services into broad categories that reflect specific human impacts.[12] Further details on the ecosystem service approach to assessing environmental benefits is provided in Appendix A of this BCA section.

2.7.3.2. Monetary Values

The ecosystem services that the restored marshlands would provide are derived from a standardized set of 21 general categories of ecosystem services. This section focuses on five of these services: recreation and tourism, aesthetic information, food, habitat, and water quality. The values of each service are presented in Table 8. These values were identified using benefit transfer methodology. All studies used in this assessment are specific to the Louisiana Delta and follow best-use guidelines of the benefit transfer method. Details on this methodology are provided in Section 1.5.6. The studies cited in the far right column are also described in the annotated bibliography in Appendix B.

Table 8. Per Acre per Year Ecosystem Service Value

Ecosystem Service	Low	High	Average	Studies Used
Recreation & Tourism	$37.49	$80.81	$59.15	Bergstrom et al. (1990)[13]
Aesthetic Information	$19.62	$108.38	$64.00	Xu, B. (2007)[14]
Food	$1.35	$12.90	$7.13	Costanza, R. et al. (1989)[15]
Habitat	$2,167.80	$2,764.44	$2,466.12	Petrolia, D. R. et al. (2012)[16]

Water Quality	$184.92	$4,583.43	$2,384.18	Breaux, A. et al. (1995)[17]
Totals	***$2,411***	***$7,550***	***$4,981***	

Table 9 shows the total value of the five ecosystem services that would be provided by the restored marshlands across all 300 acres.

Table 9. Total Annual Average Value of Ecosystem Services of 300-Acre Marsh Restoration

Total Average Ecosystem Service Value per Acre per Year	Total Restored Acres	Total Ecosystem Value per Year
$4,981	300	$1,494,300

These ecosystem service values provide an estimate of the annual flow of benefits of the restored marshlands.

If maintained and left unthreatened, marsh wetlands will provide these ecosystem services in perpetuity. In order to arrive at an asset value of the restored wetlands from the Living Mitigation project, the value is considered over 100 years. In Table 10 below, this value is calculated using both a three percent and a seven percent discount rate. Justification for the use of the three percent discount rate was provided in Section 1.3.7 above.

Table 10. Present Value Ecosystem Services of 300-Acre Marsh Restoration with 3% and 7% Discount Rates

	Total Average Ecosystem Service Value of 300-Acre Marsh Restoration	PV 100 Years (3%)	PV 100 Years (7%)
Total Value	$1,494,300	$48,634,792	$22,815,119
Per Acre Value	$4,981	$162,116	$76,050

2.7.4. Social value

Multiple social benefits result from marsh wetland restoration that will not be monetized, but will rather be described in this section. Fishing and shell fishing opportunities are one area of social benefit that will be created by marshland restoration. Previous surveys of communities in Louisiana coastal parishes demonstrate that the local population places great importance on coastal habitats and the existence of fish and other marine animal species for the purposes of fishing.[18] A regional study of the area revealed that 79 percent of households have at least one member who participates in outdoor recreational activities. 66 percent participate in fishing, 40 percent participate in hunting, and almost 20 percent participate in boating.[19] Recreation is an important part of these communities. The creation of recreational opportunities will therefore influence general quality of life, participation in physical activity, and the ability to engage in activities important to recreationalists. Wetland regeneration will provide the conditions for additional fishing and hunting recreation opportunities.

Finally, the social impacts of hurricanes can be devastating, but the protection marshlands provide can mitigate these impacts. The economic value of the storm buffering service of marsh wetlands reflects the costs that can be measured through economic indicators, such as damage to built infrastructure or loss in revenue. However, many crucial impacts remain unaccounted for using typical economic indicators. These impacts include important gains or losses such as lives lost, community relocation, or psychological trauma. For this analysis, it is not possible to quantify social phenomena such as deaths, community displacement, or pressure on social services due to a lack of biophysical data and predictive models in terms of different non-economic measures, yet these pressing social impacts should not go unnoticed.

2.7.5. Economic Revitalization

2.7.5.1. Description

Marsh restoration provides positive economic impacts through improvements in business stability in the Terrebonne region, particularly in relation to storm protection or fishing and shell fishing. Increased stability affects revenue flows, job creation, tax revenue, and income.

2.7.5.2. Monetization

To monetize economic impacts, an IMPLAN analysis was conducted. First, the cost values of each project component (see Section 1.5.1 Lifecycle Costs) were placed into the related sectors in IMPLAN. Table 12 displays each of these project components and the IMPLAN sector to which they belong. Once the project costs were allocated to a specific sector, IMPLAN was used to calculate job creation, regional sales per sector, income generation, and tax revenue. The total value added in Table 11 represents the economic activity that will occur in Terrebonne Parish as a result of the various costs associated with the marsh construction. The value added consists of four categories of impacts: employee compensation, proprietor income, other property income, and tax collection. “Other Property Income” is composed of corporate profits, rent, dividends, royalties and interest payments.

Table 11. Economic Impact of Construction

Jobs	106
Employee Compensation	$6,425,033
Proprietor Income	$182,624
Other Property Income	$1,156,686
Tax Collection	$335,460
Total (Value Added)	**$8,099,804**

Table 12. Project Components and IMPLAN Sectors

Project Component	**Sector**
Terrace Construction	58 - Construction of other new non-residential structures
Mobilization and Demobilization	58 - Construction of other new non-residential structures
Construction Survey/Layout - mark perimeter marking	449-Architectural, Engineering and related services
Quality Control (contractor performance standards)	455- Environmental and other technical consulting services
PM Oversight/QA	465- Business support services
Vegetative Planting	469-landscape/horticulture

2.8. Risks to ongoing benefits

2.8.1. Key risks and uncertainties

The project requires time and favorable environmental conditions for the propagation of the natural vegetation and inner terrace marsh creation. Under unusual circumstances, natural vegetation installments may be threatened by large storm systems, drastic changes in salinity, and human-caused development activities.

Additionally, there will be no geotextile reinforced protection from wave overtopping erosion forces. The only protection is vegetative, thus, there will be limited capacity to reduce storm surge energy (i.e. not a complete barrier).

3. BCA Project: Terrebonne Oyster Bed Attenuation

3.1. Project Description

The proposed Oyster Bed Surge Protection System will employ two artificial intertidal oyster reefs to protect the shoreline and significantly reduce erosion by providing wave attenuation along Terrebonne Bay in the Terrebonne Parish. This project will benefit both the built environment and the existing shoreline. Due to the project's location, the retention of the oyster bed will continue to provide wave and storm surge protection and will delay the erosion of Island Road and several levee structures surrounding Isle de Jean Charles. Artificial oyster reefs have been shown to be effective protection measures when installed along marsh shorelines as they provide wave protection without interfering with either navigation or oyster fishing rights.

3.2. Overview of Benefit-Cost Analysis

Table 13 provides an overview of the BCA for the Terrebonne Oyster Bed Attenuation project.

Table 13. Overview of Benefit-Cost Analysis

Value Category	Time Period	Annual Benefit Value	Annual Cost Value	Present Value Benefits (7%)	Present Value Costs (7%)	Present Value Benefits (3%)	Present Value Costs (3%)
Lifecycle Cost	5 years		$7,432,515		$7,432,515		$7,432,515
Resilience							
Environmental Value	100 Years	$29,508		$450,531		$960,393	
Economic Revitalization	5 years	$6,038,554		$6,038,554		$6,038,554	
Social Value							
			Total	$6,489,085	$7,432,515	$6,998,947	$7,432,515

	7%	3%
Benefit/Cost Ratio	0.87	0.94
Net Present Value	($943,430)	($433,568)

**Most of the costs are incurred in the first year, with minimal maintenance costs throughout the next four years. Values were not discounted.*

3.3. Overview of Terrebonne Oyster Bed Attenuation BCA

The BCA of the Living Mitigation project is organized in the following manner.

7. Description of the current environmental conditions
8. Description of the proposed project
9. Risks if the project is not implemented
10. Summary of costs and benefits
11. Risks of ongoing benefits
12. Challenges of implementation

3.4. Current situation and problem to be solved

Currently, erosion of the Terrebonne Bay shoreline marshes is resulting in substantial loss of habitat. As marshlands are lost, higher salinities and increased wave action intrude northward, where they ultimately threaten low-salinity habitats at the northern ends of the area's inter-distributary basins. The erosion of the marshes threatens both existing and proposed natural and built environment infrastructure. This project aims to protect the shoreline along Terrebonne Bay so that it becomes more resilient to storms and the effects of climate change. The proposed project follows a number of demonstration projects, among them the Terrebonne Bay Shore Protection Demonstration (TE-45), and oyster research that all support the feasibility of the effort. The TE-45 project in particular was monitored for 8 years and showed significant reductions in erosion on the banks treated with gabion mats (woven metal cages filled with rock fragments, often locally sourced).

3.4.1. What are environmental conditions in your area?

The proposed project would place oyster beds in two locations: one along the northern shore of Lake Chien, and a second along the northern shoreline of Lake Tambour.

The project restoration sites are known to be populated by oysters historically, which will provide the live fauna for the living element of the project. The salinity data mapped by the Nature Conservancy shows that Site 1 is within the ideal range all year round (5-15 ppt) while Site 2 has a higher maximum (25 ppt), but still a lower level than the most destructive predators prefer. There is every indication that this onshore installation will be successful in protecting the shoreline.

3.5. Proposal Description

3.5.1. Key objectives

The key objective of this proposal is to create a living shoreline that will protect the Terrebonne Bay shoreline and reduce marsh loss, which will in turn preserve the natural surge protection of the marshland. The project involves the placement of gabion mats along two stretches of shoreline, the northern shore of Lake Chien and the northern shore of Lake Tambour. Oysters will volunteer along the newly created substrate, creating a layer of shell superstructure that will reduce wave energy, help to prevent erosion, and protect the shoreline. The proposed project will create an estimated 4.23 acres of shellfish bed.

3.5.2. Design philosophy

Maintenance of shoreline integrity along Terrebonne Bay is a regional strategy in the Coast 2050 plan as well as the Parish Comprehensive Plan Vision 2030 and the Hazard Mitigation Plan Update 2015. This project follows a Coast Wetlands Planning, Protection, and Restoration Act (CWPPRA)-funded demonstration project, TE-45, which documented clear benefits from the placement of Gabion mats on the shoreline to disrupt wave action on the marsh.

Given the great linear distances involved in implementing this strategy, techniques less costly than traditional rip-rap armoring will likely be needed to effectively address this problem. Rip-rap has also not been as effective in recruiting and supporting oyster populations.

Armoring the shoreline can mitigate the significant erosion currently occurring in the southwest of the Parish. Mitigating erosion will protect marshes and preserve their natural surge protection properties. This restoration project may be combined with other mitigation strategies such as ridge recreation or bank stabilization if the salinity regime is sufficient.

This project is in the marsh and therefore not within a particular neighborhood. However, the two nearest communities, Island Road and Point aux Chenes, are low to moderate income on average. This living shoreline will protect the structures and infrastructure on a nearby island as well as oil field installations throughout the area. The project specifically protects eroding banks of bayous that move water and sediment though the system.

3.5.3. Timeline for completion

The Terrebonne oyster bed attenuation project will be completed in approximately five years. Table 14 provides details on this timeline.

Table 14. Project Timeline

Project Tasks	MO 1	MO 2	MO 3	MO 4	MO 5	MO 6	MO 7	MO 8	MO 9	MO 10	MO 11-12	MO 13-14	MO 15-17	MO 18 -60
Contractor Quality Control	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Engineering and Design	X	X												
Survey Private Oyster Leases		X	X										X	
Negotiating Rights-of-Way private leases	X	X	X											
Construction Survey/Layout				X			X			X		X	X	
Mobilization			X	X										
Gabion Mat placement on shoreline				X	X	X	X	X	X	X	X	X	X	
Demobilization													X	
Annual Marsh Shoreline and Elevation Assessments														X
Annual Oyster Reef Development Assessment														X
Water Quality Monitoring														X
Total Construction Schedule	X	X	X	X	X	X	X	X	X	X	X	X	X	X

3.5.4. Estimated useful life of proposal

The present generation receives a relatively small amount of the total value provided by these services; however, if a complete conservation of ecosystems is achieved in the present – meaning no further decline of ecological functions – future generations will reap huge economic benefits from healthy functioning ecosystems.

3.5.1. Alternative discount rates (in addition to 7% base-case discount rate)

One central methodological question is that of the discount factor. Discounting is designed to reflect the following:

1. Pure time preference of money: This is the value that people put on something for use now, as opposed to the value they assign for that use or income at a later date.
2. Opportunity cost of investment: A dollar in one year's time has a present value of less than a dollar today, because a dollar today can be invested for a future positive return.
3. Depreciation: Built assets such as roads, bridges, and levees deteriorate and lose value due to wear and tear. Eventually, they must be replaced.

Discounting has limitations when applied to natural capital, or ecosystem service value, however. Using a discount rate assumes that the benefits humans reap in the present are more valuable than the benefits provided to future generations, or even to this generation just a few years into the future. Therefore, it is generally recommended that natural capital assets be treated with lower discount rates (resulting in more future value being accounted for) than built capital assets because they are public goods that provide public benefits. The objective is to maximize social welfare, implying an intergenerational equity principle that calls for future generations to have a productive base at least as productive as the one we have in the present. Natural capital is often irreplaceable and relatively scarce compared to other types of capital and hence has a higher opportunity cost. Current externalities, risks, and uncertainties in markets make today's observed consumption sub-optimal and hence observed interest rates or time preferences sub-optimal as well. Incorporating these market imperfections can make the case for using discount rates for environmental services that are close to zero.[20,21]

Given the above mentioned considerations regarding the appropriate discount rate when applied to natural capital, a three percent discount rate is used in the benefit derivation in Section 1.5 below.

3.6. Risks if proposal is not implemented

The Oyster Bed Surge Protection System will benefit both the built environment and the existing shoreline. The installations are expected to protect the shoreline and provide wave attenuation to significantly reduce erosion. Due to the location, the retention of the marsh will continue to provide wave and storm surge protection and will delay the erosion of Island Road and several levee structures surrounding Isle de Jean Charles. Being outside the footprint of the Morganza Spillway, a flood-control structure northwest of the proposal site, these areas will not be protected in the future, and in fact the health of the oyster bed will be critical to the long-term maintenance of the Morganza system.

3.6.1. Impact on community as whole if proposal is not implemented

The erosion of bay shoreline marshes results in substantial loss of habitat, allowing higher salinities and increased wave action to intrude northward, ultimately threatening low-salinity habitats at the northern ends of the area's interdistributary basins. The area's infrastructure is also threatened by marsh erosion. Without implementation of this restoration project, habitat loss and erosion will continue to affect communities that remain susceptible to bigger storms. In the event of a large storm, both low income neighborhoods and oil rigs are threatened by flood waters. These structures and communities will remain exposed to more frequent and larger storms as a result of climate change.

3.6.2. Additive impacts/benefits (of multiple project components) that will not be realized is not implemented

The implementation of both oyster bed restoration areas will provide more than 38 million oysters under full maturity. The average lifespan of an oyster is five years, but can extend beyond 10 years in some cases. Once fully established, the oyster beds are expected to attract local and regional recreational and commercial fishing extraction.

3.7. Categories of Costs and Benefits

Table 15. Summary of Costs and Benefits by Category

Costs and Benefits by category	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Life cycle costs				
One row for each effect Name	The estimated costs associated with a full implementation of the project over the life cycle of the project.	A table was created (Table 14) which provides the full cost of the project over the implementation lifetime of 5 years of the project construction. The full cost estimate provides the per unit costs as well as total line item costs for the different components (construction, biological monitoring, engineering, bathymetry, oyster lease survey, oyster lease resolution, mobilization and demobilization, permanent warning signs and project management) to estimate a total project cost.	$-7,432,515	
Resiliency Value				
One row for each effect	This project looks to restore the Terrebonne oyster beds into “living shorelines.” Living shorelines are biogenic breakwater reefs which would help protect the coastal shore and communities from future storm surges, providing resiliency.	Monetizing the effect of wave attenuation was not possible due to a lack of storm surge models available. Existing studies have shown direct wave reduction and can be related to this study. One study discussed explored wave height dissipation determining that natural and restored reef treatments reduced the mean wave height by 23 percent and 25 percent respectively.		

Costs and Benefits by category	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Monetized effect (if applicable)	Uncertainty
	Resiliency provides a critical service due to the high coastal erosion and frequency of hurricanes in the region.			
Environmental Value				
One row for each effect	Environmental Value assesses the ecosystem services provided by this restoration project. Ecosystem services refer to the functions of an ecosystem that provide human benefit. A few ecosystem services examples associated with the Terrebonne Marsh restoration are potable water, food, raw materials, flood protection and recreation.	A publication of the Millennium Ecosystem Assessment (MEA) classifies ecosystem goods and services into broader categories reflecting specific human impacts. Five categories were used for this section providing an estimate for the annual ecosystem value.	$+29,508 Total Ecosystem Value per Year	
Social Value				
One row for each effect	Restoration of the oyster beds will positively impact fishing in the region.	Previous surveys show that the people of Louisiana place great value on coastal habitats and the existence of fish and other marine animal	$	

Costs and Benefits by category	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Monetized effect (if applicable)	Uncertainty
	Commercial fishing in coastal Louisiana provides a large amount of food within and beyond the state. Fishing also has strong cultural roots with oyster industry being one of the oldest commercial fisheries in Louisiana.	species for the purpose of fishing. Table 20 lists the social phenomena that were measured by the survey.		
Economic Revitalization				
Economic impact of the construction of shellfish beds	The construction of the shellfish beds will have an economic impact realized in the form job creation, regional sales per sector, economic activity or value added and tax revenue at the Parish level.	An economic assessment of the construction of shellfish beds was conducted by IMPLAN by placing the life cycle costs values above into the related sectors in IMPLAN. This gives a quantitative "value added" representing how much economic activity occurred as a result of the costs associated with the construction of the beds. The value added represents how much economic activity occurred in the Terrebonne Parish as a result of the various costs associated with the construction of the marsh.	**Value Added** $6,038,554 Employee Comp: $5,000,057 Proprietor Income: $154,417 Other Income Property: $647,416 Taxes: $236,661	
The commercial	This restoration project with	The commercial benefit will be determined by basing		

Costs and Benefits by category	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Monetized effect (if applicable)	Uncertainty
benefit provided by a thriving shellfish habitat.	create a thriving shellfish habitat. The economic impact of this habitat is realized in the form increased recreational and commercial harvest revenue.	predicted values on long-run trends. Per-pound landings price from the CFS database for each species is determined by fitting a multiple regression curve to the landings price, with year and total pounds harvested as the independent variables. For each simulation year, the total weight of catch for a single species will be multiplied by the average per-unit landings price determined by the fitted curve for that species. Finally, the total landing value over all species will be summed over each parish and input as sector-specific revenue changes in the I/O models of IMPLAN.		

3.7.1. Lifecycle costs may include:

Table 16 provides the full cost of the project over the implementation lifetime of 5 years of the project construction.

Table 16. Terrebonne Oyster Attenuation Project Budget

<u>Budget</u>		Cost per unit	#	Unit	Total Line Item Cost
Construction		$1,300,000	3.54	Miles	$4,602,000
Biological Monitoring					$700,000
	Labor and Supplies	$625,000			
	Gauges and Equipment	$75,000			
Engineering					
	Engineering Design	7.58%	$4,602,000	FP&C B Curve	$348,832
	Initial Soil Survey	$7,500	10	days	$75,000

	Construction Management	$2,000	90	days	$180,000
	Survey Monitoring - Engineer	$66,000	5	years	$330,000
Bathymetry		$40,000	1		$40,000
Oyster Lease Survey		$50,000	1		$50,000
Oyster Lease Resolution*		$30,000	10		$300,000
Mobilization and Demobilization		$62,500	2		$125,000
Permanent Warning Signs		$1,000	6		$6,000
Subtotal					**$6,756,832**
Project Management					$675,683.2
Total:					**$7,432,515***

**Value is not discounted over the lifetime of the project. See Table 13 for the discounted value.*

3.7.2. Resiliency value

Coastal regions, and particularly shorelines where marine, estuarine and terrestrial zones meet, are increasingly threatened by sea level rise, storms, and human impacts. In recent years, shoreline protection efforts have shifted from projects such as bulkheads and seawall construction to what has been termed "living shoreline" approaches.[22] One such approach is the artificial reef, a less detrimental alternative that has been used for decades to protect harbors and anchorages. While artificial reefs serve a variety of purposes, their use for the dissipation of wave energy is particularly well established.[23,24,25] The oyster bed restoration under this project would implement this type of breakwater reef to protect the coastal shore and communities from storms.

It was not possible to monetize the benefit of wave attenuation due to a lack of storm surge models; however, existing studies can provide direct wave reduction data that can be utilized for this project. One study explored the effects of oyster reef restoration on wave height dissipation and determined that natural and restored reef treatments reduced the mean wave height by 23 percent and 25 percent, respectively.

3.7.3. Environmental value

The Oyster Bed Surge Protection System will benefit both the built environment and the existing shoreline. The installations are expected to protect the shoreline and provide wave attenuation that will significantly reduce erosion. Due to the project's location, the retention of the marsh will continue to provide wave and storm surge protection and will delay the erosion of Island Road and several levee structures surrounding Isle de Jean Charles. Being outside the footprint of the Morganza Spillway, a flood-control structure northwest of the proposal site, these areas will not be protected in the future. In fact, the health of the marsh will be critical to the long-term maintenance of the Morganza system.

Further benefits of this project include oyster cultch development as well as observations of fishery support and bird populations. Water quality is also expected to benefit from the filtering capacity of the oysters. However, due to budget constraints and the project's focus on erosion control, these benefits will not be quantified.

Considerable progress has been made in systematically linking ecosystem functions with human well-being. Ecosystems perform many functions, but the term "ecosystem services" specifically refers to functions that provide human benefits. Ecosystem services are "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life." Many gains and losses from a changing environmental landscape can be classified into ecosystem service categories. A few prime examples of these services are potable water, food, raw materials, flood protection and recreation. A key advancement in this conceptualization of human dependence on nature was the publication of the Millennium Ecosystem Assessment (MEA), which classified ecosystem goods and services into broad categories that reflect specific human impacts.[26] Further details on the ecosystem service approach to assessing environmental benefits is provided in Appendix A of this BCA section.

3.7.3.1. Monetary Values

The list of ecosystem services provided within the proposal sites is derived from a standardized set of 21 general categories of ecosystem services potentially found in shellfish beds typical of this region of the Gulf Coast. This section focuses on five of these services. Table 17 shows the values for recreation and tourism, soil erosion control, food, habitat, and water quality provided by marsh wetland systems that would result from the Terrebonne marsh restoration.

Table 17. Per Acre per Year Ecosystem Service Value

Ecosystem Service	Low	High	Average	Studies Used
Recreation & Tourism	$37.49	$80.81	$59.15	Bergstrom et al. (1990)[27]
Soil Erosion Control	$364.80	$364.80	$364.80	Grabowski et al. (2012)[28]
Food	$373.29	$9,314.78	$4,844.04	Grabowski et al. (2012)[28]
Habitat	$9.04	$548.05	$278.55	Costanza et al. (1989)[29] Grabowski et al. (2012)[28]
Water Quality	$9.43	$2,848.86	$1,429.15	Grabowski et al. (2012)[28] Pollack et al. (2013)[30]
Totals	***$794***	***$13,157***	***$6,976***	

The methods used to derive these values are described in Appendix A below. The studies cited in the far right column are also described in the annotated bibliography in Appendix B.

An estimated 4.23 acres of shellfish bed will be created under the oyster bed attenuation project. Table 18 shows the total value of the combined ecosystem service values provided by the restored shellfish beds across all acreage.

Table 18. Total Annual Average Value of Ecosystem Services of 300 Acre Marsh Restoration

Total Average Ecosystem Service Value per Acre per Year	Total Restored Acres	Total Ecosystem Value per Year
$6,976	4.23	$29,508

These ecosystem services provide an estimate of the "yearly income" or the annual flow of benefits, similar to the value of yearly rent for a house. Considering this value across time provides the ability to appraise the full value of an asset (like the appraised value of a house). The net present value is a critical measure of the overall magnitude of any economic asset.

If maintained and left unthreatened, the oyster beds will provide value in perpetuity. In order to arrive at an asset value of the restored oyster beds, the value is considered over 100 years. In Table 19 below, this value is calculated using both a three percent and a seven percent discount rate. Justification for the use of the three percent discount rate was provided in Section 1.3.7 above.

Table 19. Present Value Ecosystem Services of Oyster Bed Restoration with 3% and 7% Discount Rates

	Total Average Ecosystem Service Value of Oyster Bed Restoration	PV 100 Years (3%)	PV 100 Years (7%)
Total Value	$29,508	$960,393	$450,531
Per Acre Value	$6,976	$227,043	$106,509

3.7.3.2. Description of Valuation Methodology

Though there are many methodologies for valuing ecosystem services, the methodology best suited to this analysis is Benefit Transfer Methodology (BTM). Benefit Transfer Methodology (BTM) is a well-established methodology that indirectly estimates the value of ecological goods or services. BTM is frequently used because it can generate reasonable estimates quickly and at a fraction of the cost of conducting local, primary studies that may cost upwards of $50k to $100k per service/land cover combination. For more information on this methodology, please refer to Appendix A.

3.7.4. Social value

Commercial fishing in coastal Louisiana provides a large amount of food to communities within and beyond the state. The top Louisiana fisheries by value are shrimp, menhaden, blue crab, and oysters. The commercial fishing sector has tremendous importance in Louisiana beyond providing food, as this sector employs many people and sustains a large economy. Fishing also has strong cultural roots. The oyster industry is one of the oldest commercial fisheries in Louisiana, dating back to the early 1800s when oysters were harvested for local consumption.

Previous surveys of communities in Louisiana coastal parishes demonstrate that the local population places great importance on coastal habitats and the existence of fish and other marine animal species for the purposes of fishing.[31] See Table 20 for a list of social phenomena that was measured in the survey.

Table 20. Social Phenomena Addressed in the Commercial Fisheries Impact

Social Phenomena	Methodology to Address
Job Satisfaction	Increases with fisheries catch abundance
Job Availability	Increases with fisheries catch abundance
Access to Food and Raw Materials	Increases with fisheries catch abundance
Cultural Heritage and Identity	Decreases with reduction in fishing jobs

3.7.5. Economic Revitalization

The Commercial Fishing Statistics database by the National Marine Fisheries Service (NMFS),[a] the Gulf FINFO database by the Gulf States Marine Fisheries Commission,[b] and economic reports and statistics by

[a] Available on-line at http://www.st.nmfs.noaa.gov/commercial-fisheries/.
[b] Available on-line at http://gulffishinfo.org/

the Louisiana Department of Wildlife and Fisheries (LDWF)[c] all recognize the importance of shellfish as renewable resources that are commercially vital. Multiple shellfish species are commercial species, meaning that those species are commonly sold in Louisiana's commercial fishing sector. The restoration of the shellfish oyster beds in lower Terrebonne Bay would further enhance the region's shell fishing community. The economic value of the shellfish restoration project will be assessed in two ways: 1) the economic impact from the construction of the shellfish beds, and 2) the commercial benefit provided by a thriving shellfish habitat.

3.7.5.1. Economic Impact from Construction

For economic impacts, total industry revenue was allocated to the economic sectors that are affected within each impact category. From these sales, IMPLAN calculated job creation, regional sales per sector, economic activity (represented by "Value Added"), and tax revenue at the parish level. The value added is separated into taxes, employee compensation, proprietor income and other property income, which includes corporate profits, rent payments, dividends, royalties, and interest income.

An economic assessment of the construction of the oyster beds was conducted in IMPLAN by placing the cost values from the Life-Cycle Costs Section above into the related sectors in IMPLAN. Table 22 below indicates what IMPLAN sector each project component was attributed to. The value added in Table 21 represents how much economic activity occurred in Terrebonne parish as a result of the various costs associated with construction of the wetland.

Table 21. Economic Impact of Construction

Jobs	*72.1*
Tax Collection	$236,661
Employee Comp.	$5,000,057
Proprietor Income	$154,417
Other Property Income	$647,416
Value Added	**$6,038,554**

Table 22. Project Components and IMPLAN Sectors

Project Component	**Sector**
Construction	58 - Construction of other new non-residential structures
Biological Monitoring	455 - Environmental and other technical consulting services
Engineering	449-Architectural, Engineering and related services
Bathymetry	455- Environmental and other technical consulting services
Oyster Lease Survey	455- Environmental and other technical consulting services
Oyster Lease Resolution	447 – Legal Services
Mobilization and Demobilization	58 - Construction of other nonresidential structures
Permanent Warning Signs	58 - Construction of other nonresidential structures
Project Management	454 – Management Consulting Services

[c] LDWF commercial fishing statistics are recorded on-line at http://www.wlf.louisiana.gov/licenses/statistics. LDWF commercial fishing economic reports are recorded on-line at http://www.wlf.louisiana.gov/fishing/economic-reports.

3.7.5.2. Recreational and Commercial Harvest Value

[Description of methodology on shellfish production]

The number of shellfish harvested will be valued using market prices derived from the Commercial Fisheries Statistics (CFS) database by NMFS.[d] These values represent the landings, or dollar value paid to the harvester. Prices often vary depending on factors such as the scarcity of a resource (the amount of fish caught), consumer demand, the availability of substitutes, catch in other regions, the number of consumers, and food trends (for example, popularity). However, many of these market perturbations cannot be predicted in a 50-year analysis. Overall, seafood prices have risen relative to inflation across the last 50 years. Overall, these dynamics are only visible year-on-year.

A reasonable approach for a long-run analysis is to base predicted values on long-run trends. Per-pound landings price from the CFS database (ranging from 1950 to 2012) for each species is determined by fitting a multiple regression curve to the landings price, with year and total pounds harvested as the independent variables. For each simulation year, the total weight of catch for a single species will be multiplied by the average per-unit landings price determined by the fitted curve for that species.

For example, if in Year 10 of the model simulation, 10 million pounds of oyster are harvested, the price per pound determined from the multiple regression would be $4.27.

The regression equation is:

$$Price\ per\ pound = 0.06 * [year\ of\ catch] - (6.7 * 10^{-8}) * [total\ pounds\ caught] - 120.4$$

The equation has an R square of 0.9 and all coefficients are highly significant. Figure 1 contains a visual of the multiple regression equation for oysters compared with the plotted data from the CFS database.

[d] The database is available on-line at http://www.st.nmfs.noaa.gov/commercial-fisheries/.

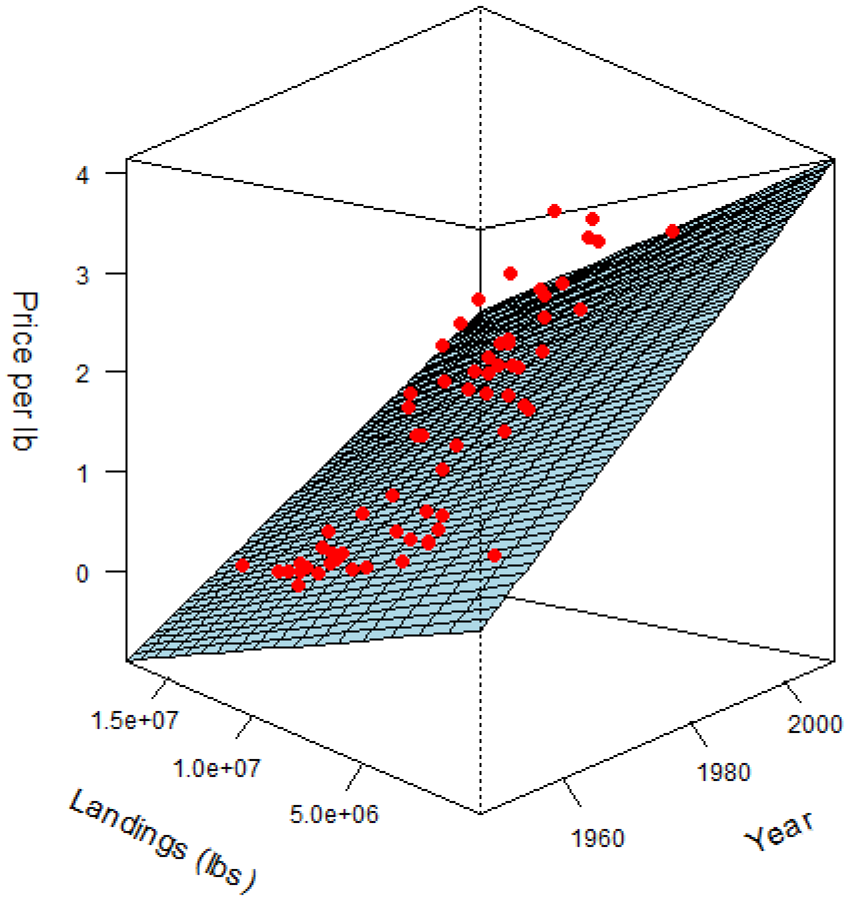

Figure 1: Graph of the multiple regression equation (blue surface) determined for oysters and oyster landings data from CFS (red dots)

Last, the total landing value over all species will be summed over each parish and input as sector-specific revenue changes in the I/O models of IMPLAN.[e] These models will estimate the economic repercussions of changes in commercial fishing within local economies under the FWOA and FWA scenarios. This analysis will produce estimates of local business sales, employment, tax revenue, and income for the industries tied to the fishing sector. A comparison of the scenarios will show the economic impact of sediment diversions in relation to the expected changes in commercial fisheries.

3.8. Risks to ongoing benefits

3.8.1. Key risks and uncertainties

In the event of a large storm within the lifetime of the project, construction efforts may be lost or become more costly due to damage and changing environmental conditions. However, once established, the shellfish beds will be self-sustaining, requiring little and, eventually, no maintenance.

[e] This aggregation is necessary as the industry codes used in IMPLAN aggregate all commercial fishing activity into one industry (17, Commercial Fishing).

4. BCA Project: St. Johns Water Works

4.1. Project Description

In 2012, Hurricane Isaac's 80-mph maximum sustained winds and 8.4-foot storm surge in Lake Pontchartrain and Lake Maurepas caused record flooding in several subdivisions of Laplace, the largest city in St. John the Baptist Parish. Floodwaters rising to more than 6 feet forced the closure of Interstates 10 and 55. During the worst of the storm and its aftermath, 95 percent of parish households were without power, while Laplace residents went without water and sewer functionality for four days due to a decision made early on to protect an important well from serious damage.

To prevent future shutdowns of water and sewer services, St. John the Baptist Parish is investigating potential upgrades to their water supply system for the East Bank of the Parish. The project, entitled "Conceptual Engineering of Mississippi River Water Source for Laplace", evaluates six distinct projects that propose a variety of solutions and improvements to the existing facilities.

4.2. Overview of St. Johns Water Works BCA

The BCA of the Living Mitigation project is organized in the following manner.

13. Description of the current environmental conditions
14. Description of the proposed project
15. Risks if the project is not implemented
16. Summary of costs and benefits
17. Risks of ongoing benefits
18. Challenges of implementation

4.3. Current situation and problem to be solved

The St. John Waterworks projects, rather than addressing a current issue, propose preventative action that is aimed to avoid water supply issues similar to those experienced following Hurricane Isaac. As stated in the introduction to this proposal, Laplace residents were without water and sewer functionality for four days during the aftermath of Hurricane Isaac. The projects under evaluation would improve the existing systems and prevent future shutdowns. This area is greatly in need of a more sustainable and secure water supply source.

In upgrading their water supply system for the East Bank, St. John the Baptist Parish is responding to projections that indicate future population growth that could strain the water supply. The Laplace population is expected to grow from 43,745 to 65,110 by 2030.[32] In all likelihood, future threats to Laplace's water supply will be under large storm conditions. This project is intended to provide Laplace communities with a more resilient water supply system that is less susceptible to storm damages.

4.4. Proposal Description

St. John the Baptist Parish is investigating six potential upgrades to their water supply system for the East Bank of the Parish:

1) a new intake pump station on the Mississippi River in Laplace
2) a new transmission water main from the Mississippi River to the reverse osmosis unit site on Woodland Drive
3) water pre-treatment at the reverse osmosis unit site on Woodland Drive
4) modifications to the Lions Water Treatment Plant

5) a new distribution pump station and transmission water main from the Lions Water Treatment Plant to Laplace
6) operation and maintenance costs to maintain the Ruddock Well System vs the cost to decommission the well system

4.4.1. Key objectives

This project involves two primary objectives. The first objective is to provide a more secure water supply source to the 43,000 residents of Laplace. The six water supply upgrades identified above would extract and treat water directly from the Mississippi River and provide it to the nearby residents of Laplace. This would effectively replace the existing water supply, which is currently highly susceptible to damage and shutdown during large storm events such as Hurricane Isaac.

The second objective is to provide future generations with a more resilient water supply system that is less susceptible to threats from future storms. These water supply system upgrades accommodate future population growth in the region, as the community is expected to grow by just over 20,000 residents within the next 15 years.

4.4.2. Design philosophy

The proposed Mississippi River Intake Pump Station will supply Laplace with an alternative water source from the Mississippi River with the capacity to deliver up to 8.64 MGD (6,000 gpm). The project's goal is to provide a new alternative water source for Laplace, in conjunction with a new water transmission main route to a reverse osmosis treatment plant. The intake pump station and new transmission water main would serve as the infrastructure for this new system, undergoing a treatment process of raw water. The Lions water treatment system currently cannot meet current TOC reduction requirements, especially during the summer. The Parish would like to upgrade its facility to maintain "current" capacity of 3 million gallons per day (not currently met). The new system would meet these requirements.

The intake pump station will be located on the Mississippi River batture at an optimal site for pumping raw Mississippi River water to the reverse osmosis unit site on Woodland Dr. The pump station will pump into a new 24-inch inner diameter raw water transmission main. This capacity was sized to match the recovery rates for the Future Reverse Osmosis treatment capacity of 6 million gallons per day which requires a pre-treatment system and intake capacity from the Mississippi River of 8 million gallons per day.

4.4.3. Timeline for completion

The Waterworks project is projected to be completed within a 30 month timeline. Table 23 below shows the timeline per project.

Table 23: Waterworks Project Timeline

Projects	MO 1-3	MO 4-6	MO 7-9	MO 10-12	MO 13-15	MO 16-18	MO 19-21	MO 22-30
Water Intake Pump Station	X	X	X	X	X	X		
Clarifier, Sludge Return and Transmission Water Main from MS River	X	X	X	X	X	X		
Water Pre-Treatment and Reverse Osmosis Unit	X	X	X	X	X	X	X	X
Modification to the Lions Water Treatment Plant	X	X	X	X	X	X	X	X

Distribution Pump Station for Lions Treatment Plant to Laplace	X	X	X	X	X			
Transmission Water Main from Lions Plant to Laplace	X	X	X	X	X	X		
Decommission Ruddock Well System	X	X	X	X				
Total Construction Schedule	X	X	X	X	X	X	X	X

4.4.4. Estimated useful life of proposal

4.5. Risks if proposal is not implemented

If the water supply system is not upgraded, communities could face significant health costs due to water supply loss in the event of a large storm. The financial loss is not the only risk for residents, however. The associated stress to the local population and lost productivity (worker days) are also risks. Besides local costs and risks, failed water supply could also result in federal costs for water supply shipment during disaster events.

4.5.1. Realistic expectations in 5, 20 and 50 years if proposal is not implemented

If this proposal is not implemented, the entire Laplace community will remain at risk of water supply shutdowns in large storm events. NOAA storm and rainfall frequency data suggests that Laplace will experience 77 percent and 126 percent increases in minor rainfall events over 10 and 25 years, respectively, and a 53 percent to 80 percent increase in large storm events over 10 and 25 years, respectively.[33] Not only will existing communities face these threats of water supply loss, but future generations will likely continue to experience the same water supply loss.

4.5.2. Areas of concentrated poverty adversely affected by impact qualifying disaster if proposal is not implemented

4.6. Categories of Costs and Benefits

Table 24 shows the summary of costs and benefits for each of the five HUD categories: lifecycle costs, resiliency value, environmental value, social value, and economic revitalization. Each category is described qualitatively, quantitatively, and with monetized benefits. Each category is then described in detail in subsequent sections, followed by a description of the methodology used to assess the value of this project.

Table 24. Summary of Costs and Benefits by Category

Costs and Benefits by category	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	**Monetized effect (if applicable)**	**Uncertainty**
Life cycle costs				
One row for each effect Name			$	
Resiliency Value				

One row for each effect			$	
Environmental Value				
One row for each effect			$	
Social Value				
One row for each effect			$	
Economic Revitalization				
One row for each effect			$	

4.6.1. Lifecycle costs

Table 25 includes the costs associated with the full implementation of the project over the lifetime of the project.

Table 25. Project Costs

Projects
Project 1: Project 1-Cost Estimate for Intake Pump Station
Project 2: Project 2a-Cost Estimate of Transmission Water Main
Project 2: Project 2b-Cost Estimate of Pre-Treatment near Raw Water Intake Site
Project 3: Project 3-Cost Estimate of Water Pre-Treatment and Reverse Osmosis Unit
Project 4: Project 1a-MF/UF Membrane Filtration in a Post Granular Media Filtration Treatment Step for a 3 MGD
Project 4: Project 1a-MF/UF Membrane Filtration in a Post Granular Media Filtration Treatment Step for a 6 MGD
Project 4: Project 1b-Low Pressure Organics Removal Membrane Treatment in a Post-Granular Media Filtration Treatment at 3
Project 4: Project 1b- Low Pressure Organics Removal Membrane Treatment in a Post-Granular Media Filtration Treatment at 6
Project 4: Option 2-MIEX® Pre-Treatnebt in Conjunction with Existing Process Trains at 3 MGD Production Rate
Project 4: Option 2-MIEX® Pre-Treatnebt in Conjunction with Existing Process Trains at 6 MGD Production Rate
Project 4: Cost Estimate of Raw Water Control Valves and Ground Storage Tank Short Circuiting
Project 4: Cost Estimate for Ground Storage Tank Piping
Project 5: Table 5.1-Cost Estimate of Distribution Pump Station
Project 5: Table 5.1-Cost Estimate of Recommended Route
Project 6: Project 6.1-Cost Estimate to maintain Ruddock Well System
Project 6: Project 6.2-Cost Estimate to decomission Ruddock Well System
Total Cost of Projects

4.6.2. Resiliency value

The implementation of the waterworks projects will create a water supply system that will be more resilient in the face of future storm conditions, while allowing for projected population growth to occur without further water supply stress. Future generations will not be as susceptible to water supply loss and its resulting costs. Without project implementation, the community faces the same threat under similar storm conditions. Residents, commercial businesses, and local industries reliant on water would have to cease production, and economic activity would come to a halt. This section will focus entirely on this loss in productivity under data gap limitations.

The productivity of many Louisiana businesses is dependent upon the availability of freshwater. Saltwater intrusion is one of the most concerning threats to the water supply extracted in the Delta, and hence only this parameter will be used for industry-level impacts. An unplanned saltwater intrusion into a water extraction point could render a water supply unusable for a considerable time before a new source could be accessed or desalination equipment could be deployed. Water consumption needs can be met through shipping freshwater, but the disruption time can significantly impact business operations. Industries that draw large volumes of water (i.e., 40+ Mega gallons/day), such as power generation, chemical manufacturing and petroleum refining, may be heavily impacted.

Impacts of water shortages on industrial output have been identified via surveys and analyses of output following water supply disruptions due to earthquakes.[34] The economic activity reductions associated with water losses have been analyzed through "resilience factors." These factors indicate the percentage of production reduction that can be expected within each industry given water outages of various durations (<1 week, 1-2 weeks, and > 2 weeks). Other authors have developed methods for estimating partial water outages. For the purposes of this analysis, the level of water loss observed in each scenario and industry-specific resilience factors from the literature review have been used to estimate productivity losses associated with partial outages.[35]

Economy-wide impacts were estimated within St. John the Baptist Parish IMPLAN models. This model was based on a recreation of the scenario experienced during Hurricane Isaac: four days of water loss. The two industries (oil refining and chemical manufacturing) used to represent the potential effects of water shortages on the private sector were modeled in terms of output losses resulting from the observed water outages. Total effects on related industries, jobs, income, and tax revenue were then calculated for the four day water loss scenario in Table 26.

Table 26. Economic Activity Loss Scenario

Jobs Effect	139.81
Employee Compensation	$6,059,944.00
Proprietor Income	$1,025,072.00
Other Property Income	$11,784,498.00
Indirect Business Taxes	$986,056.00
Total Value Lost	**$19,855,569.00**

Table 26 shows the economic value loss in Laplace as a result of water supply loss during Hurricane Isaac, but this value is realized as a benefit (avoided cost) in the event that the waterworks project is implemented. With the water infrastructure updates, the community avoids this potential loss in the event another storm occurs. This benefit value is reflected in the summary BCA Table 1.

4.6.3. *Environmental value*

The implementation of the six waterworks tasks identified above will not provide a direct environmental benefit, and thus a monetary value will not be provided in this section. However, removing dependence on the existing water infrastructure may result in avoided costs applicable to this project. There are many landscape and hydrological characteristics that affect water supply. For example, the amount of water available at a given site, the existence of reservoirs for storage, or other potentially polluting uses of the river all affect the water supply. Surface water reservoirs such as those currently supplying water to the Laplace residents are at risk of being polluted, and thus unsuitable for human consumption. The infiltration of saltwater into water intake sites can be a major cause of water supply impacts.

4.6.4. *Social value*

The largest unmeasured cost that resulted from Hurricane Isaac was the social cost to Laplace citizens. The entire community lost water supply for four days and nearly 6,000 residents and 200 pets were evacuated from their homes.[36] Additionally, the mental health costs attributed to experiencing home evacuation and general post-storm conditions were wide-ranging, yet remained unmeasured.

A survey on coastal infrastructure in Louisiana asked nearby residents of the Mississippi River Delta, Breton, Barataria, and Pontchartrain Basins (southeast of Laplace) to determine what environmental goods were most important to them.[37] The survey included benefits such as reduced storm surge flooding risk, habitat, promoting a viable working coast, and availability of fresh water. Results showed that, on average, respondents placed “Availability of Freshwater” among the most important services, second only to reduced flood and storm surge risk.[37] Another local resident survey on the perceived effects of the Bayou Lafourche diversion revealed that the majority of respondents familiar with the diversion project favored the goal of improving water quality.[38] The social phenomena linked to water supply consistency featured in this analysis are outlined in Table 27.

Table 27. Social Categories of Water Supply

Social Phenomena	Methodology to Address	Source/Link to Data
Access to Capital for Investment	Access to capital decreases with business uncertainty and business uncertainty increases with water supply disruption.	Pergram, G. 2010. Global Water Scarcity - Risks and Challenges for Business. Lavington, F. 1912. Uncertainty in its Relation to the Net Rate of Interest
Violation of Human Rights	Access to water as a human right.	World Health Organization. 2003. The Right to Water.
Access to Education	Increased hydration leads to increased cognitive performance in school children.	Fadda et al. 2012. Effects of drinking supplementary water at school on cognitive performance in children.

Energy Security	Power plants impacted by water disruption.	Output of water supply analysis

4.6.5. Economic Revitalization - TBD

To determine economic impacts, total industry revenue was allocated to the economic sectors that are affected by the waterworks project investment. Once allocated, IMPLAN was used to calculate job creation, regional sales per sector, income generation (represented by "Value Added"), and tax revenue at the parish level.

5. BCA Project: Isle de Jean Charles Resettlement

5.1. Overview of Project

The project consists of the design and development of a resettlement community, in three phases over three years. Once completed the development will house 100 families, as well as including a Community Center, public areas, and some retail. It is being designed so that the community can grow during the ensuing generations with extended family. Depending upon the characteristics of the land acquired, the development may incorporate economic development aspects which are also beneficial in terms of the environment, such as conservation easements or wetland banking opportunities.

5.2. Overview of this BCA

The BCA of the Living Mitigation project is organized in the following manner.

19. Description of the current environmental conditions
20. Description of the proposed project
21. Risks if the project is not implemented
22. Summary of costs and benefits
23. Risks of ongoing benefits
24. Challenges of implementation

5.3. Current situation and problem to be solved

The Isle de Jean Charles Native American tribe located in coastal Louisiana, a region that leads the world in land loss,[f] is ideally positioned to develop and test resettlement adaptive methodologies because their need to resettle is urgent. Until the new millennium, the Tribe's self-sufficiency and ability to adapt to change and maintain culture at the site of their community were strong and allowed most tribal families to remain on the site called "The Island". After years of exposure to hurricanes, tidal surges, and land loss, the tribe has no choice but to resettle. Subsidence, storms and sea level rise have washed away more than 98% of their land. In fact, over decades, many of the tribal members out of necessity rather than choice have had to relocate away from their tribal homeland and community, because of safety considerations and loss of homes and livelihood. But as important as it is moving to

[f] Coastal Louisiana experiences rising waters, subsiding land due to the aging of the Mississippi delta, loss of land because the marsh plants die due to the salt-water inundation and the flow of salt water more rapidly through the marshes via canals used for oil and gas exploration and historic first growth cypress harvest. 9/1/15

safety, equally important is retaining and strengthening their cultural practices, identity as a community, and building economic and social stability to ensure self-reliance. The process will begin with a comprehensive reunification plan around resettlement that will be guided by the tribe's indigenous knowledge of environment and their relationship with it. By doing so, the tribe is ensuring cultural, ecological, social, and economic stability over generations

5.3.1. *What are environmental conditions in your area?*

Resettlement is essential to the tribal families still remaining on The Island and close proximity to the Island as their homes are at continual extreme risk, even from flooding at high tide with a southerly wind. Storm damage has left many of their homes almost inhabitable – mold, rotting of walls and floors, inadequate roof coverage, broken and missing windows. They do not have insurance nor the money to pay personally for the damage repair. Whatever repairs have been done are done by the residents or volunteers from nonprofit or religious groups. The tribal residents simply live in the sub-par conditions.

The tribal residents are currently at risk of permanently losing their land bridge (an asphalt causeway) to the mainland in the next coastal storm. The county (parish) government which repaired the road after Hurricane Gustav with federal funds (cost 6.24 million) representing an expenditure of $280,000 per household, will not repair it again, leaving the Island accessible only by boat. Most of the residents do not have boats nor can they afford to buy them and for many the 2.4 miles of travel would not be easy on a consistent basis. There are no practical plans in place to halt the erosion of their land beyond a small levee on one side of the Island. Thus the erosion will continue in each ensuing storm.

5.4. Proposal Description

5.4.1. *Key objectives*

The overarching goal is to create a teaching-learning community, a pilot site for climate change relocation with tribal livelihoods enhanced by innovation, teaching and sharing activities while traditional cultural traditions are rekindled with the tribal members living in one community rather than scattered as they are today – some on The Island and others living in surrounding villages and towns.

5.4.2. *Design philosophy*

In visioning a culturally appropriate, healthy and sustainable community, utilizing best practices, the tribe anticipates the successful resettlement will include innovative technologies and state-of-the-art resilience measures, integrating historical traditions and proactive solutions for this time of change. These efforts can help not only Isle de Jean Charles but will also lead other communities to implement appropriate relocation measures when the conditions of their coastal locations warrant such.

5.4.3. *Main components of proposal plan*

A series of tribal strategic planning meetings, using a systems planning approach to achieve a robust plan and one that is generalizable, are being conducted to embrace and inform the important stages of their relocation. From these meetings the first-stage scope has been delineated. Future facilitated meetings will focus on land characteristics and usage, assessment of resources, desired housing designs, members' skills and interests for assisting in its construction and management, and evaluation of options for livelihood development based on historical practices, available resources and characteristics of place.

The acquisition of a site for relocation is the first major phase in providing a planned healthy community. Sites are being evaluated for their suitability for raising families, for growing food, for having characteristics as similar to their original site as possible and as safe as possible within the context of coastal Louisiana. As a site with reduced risk is being sought, the location should not be extremely far from the original site in order to retain traditional livelihood and cultural practices. All factors of the design and process will help to support and enhance tribal identity, sovereignty and dignity.

The new site is envisioned as a practical, affordable, living demonstration of a tribal resettlement. Tribal community input, vision and leadership will be, core to all phases of the design of a site that meets current and future needs and desires while tracking previous Island life, resources and infrastructure to the maximum feasible. Individual family gardens, localized flooding and water management methods will be used to treat water as a resource rather than a problem. Bioswales, strategic tree planting and community parks and play areas will be multi-functional and will receive excess rainwater (stormwater detention) as well as provide locations for recreation and community interaction dynamics.

The structures will be created with resilient design methods that include extreme storm risk reduction, low-tech infrastructure and design and energy efficiency. The process will examine modest-income comparables nationwide. First floor elevations will meet both current requirements and anticipated increases (i.e. 'freeboard'). Renewables will be emphasized such as solar, earth-coupled (or water-coupled) heat pump systems, with wells shared by clustered homes, and locally-sourced building materials and equipment. Tribe members will have the opportunity to be trained in advanced sustainable building technology and participate in construction of new homes while gaining capacity for employment in the region. Other green approaches will include construction waste reduction, pervious paving and pedestrian-friendly community/commercial facilities. Wastewater innovations are also transferable globally.

A Community Center will be constructed in the first phase along with the initial homes – to be constructed in three phases. The center will immediately serve as an anchor for the tribe replacing an equivalent traditional gathering place. It is intended to be a point of contact with the land, a place for meetings, rituals and evolution of site development. Its design includes temporary residential space that will double as refuge in the event of storms that threaten the existing homes of the tribal community. Housing designs will include layouts suitable for seniors and others who require assisted living, homes large enough for extended families and space for the next generation's homes near their elders. The community will be constructed as flexibly as possible so that as functions and uses emerge, the structures and infrastructure will be appropriate for current as well as these future goals. And as long as The Island exists, it will be retained for traditional uses and tribal identification as all the members relocate. It is expected that the connecting road will very soon be impassible and thus the access will be only by boat.

Regional environmental degradation by the extraction industry and farming may present an opportunity for the Tribe to gain expertise and develop entrepreneurial capacity in remediation of brownfield sites and/or coastal restoration, using advanced, low-impact, non-invasive technologies. Through creation of such high-profile competitions as the annual Water Challenge, Louisiana is taking a leadership position in water resource research and coastal mitigation entrepreneurship. The relocation of Isle de Jean Charles will be a model project offered for review in that innovation process.

5.4.4. Timeline for completion

Regarding the schedule, we consider the first phase as consisting of the primary community areas as well as an initial 20 houses. The second phase will incorporate additional community elements while also expanding the housing stock up to 50 families. The third phase will include the completion of the development with a total of 100 homes constructed.

5.5. Risks if proposal is not implemented

5.5.1. Impact on community as whole if proposal is not implemented

With the loss of land over the past 60 years, the Isle de Jean Charles Native American tribe has struggled to maintain the integrity of their community. No action will result in a complete displacement of a community of cultural importance in the region.

Without assistance, relocation may be completed without investment in resentment. Forced displacement with no attempt to resettle the community can lead to "marginalization, loss of resilience, livelihoods and traditional skills, health and education risks, break up of family and social groups and communities and the mental stress of living in a strange place."[39]

5.6. Categories of Costs and Benefits

Tribal members have developed a process with the assistance of nationally recognized experts to obtain the goals of community resilience, health and wellbeing. This proposal strengthens the cultural survival of the tribe by focusing on the restoration of environmental features that are liken to their place of origin, disaster resilient structures that emerge from their cultural values and traditions, and socioeconomic models that support self-sufficiency for the tribe.

The project is described in detail in the following sections with a description of the methodology used to assess the value of this project

5.6.1. Lifecycle costs

Table 28. Project Costs

Housing	$23,800,000
Physical Infrastructure	$28,800,000
Utilities	$14,460,000
Tribal Center	$25,000,000
Land Acquisition	$15,000,000
Total	**$107,060,000**

We are striving for a 35% match.

5.6.2. Resiliency value

This project addresses the risk of future and repeated wind and flooding disasters. Tribal members will have the opportunity to relocate to an area with less risk of continuous storm damages and flooding to land, thus clearly reducing the expected property damages.

The tribal residents are currently at risk of permanently losing their land bridge (an asphalt causeway) to the mainland in the next coastal storm. The county (parish) government which repaired the road after Hurricane Gustav with federal funds (cost 6.24 million) representing an expenditure of $280,000 per household, will not repair it again, leaving the Island accessible only by boat. Most of the residents do not have boats nor can they afford to buy them and for many the 2.4 miles of travel would not be easy on a consistent basis. There are no practical plans in place to halt the erosion of their land beyond a small levee on one side of the Island. Thus the erosion will continue in each ensuing storm.

Under the conditions described in the above paragraph, relocation must occur in order to decrease the risk to the vulnerable population and to improve their resilience. In order for the tribal culture to be retained and revitalized after the scattering of the tribal members due to the conditions described in the previous paragraph, the action must include the co-location of the tribal members from the Island with those who were driven away and are scattered about the coastal area.

Tribal leadership is committed to energy independence and efficiency for the community, a strong expression of cultural integrity and tribal sovereignty. Self-generated electricity is a lifeline for a population when the grid is interrupted for an extended period of time, such as in hurricanes. The potential for Combined Heat and Power (CHP) will be evaluated. CHP can serve as the primary source of power, fueled by natural gas, biomass or propane. As a renewable, methane can be collected from landfills, wastewater treatment plants or other processes. To advance toward implementation, financing options, including repayment through energy savings will be evaluated and presented. Waste heat from generator operation can be used, for example, in a value-added food processing facility to employ community members.

To reduce risk and enhance vulnerability, the planning team of tribal members and the Core Team has drawn upon the best practices studies in earlier ground-breaking work (Oliver-Smith, 2010[40]), identified in international publications produced over the last couple of decades especially by the United Nations and very recent publications by HUD in collaboration with Enterprise Foundation, with Sustainable Tribal Communities and EPA on the building of tribal housing and communities. The important goals stemming from key values are clearly delineated. The Lowlander Center principles have been involved in creating, reinforcing and honing these values over the last decades. IDJC tribe has demonstrated adherence to them in the 20 year effort that they have pursued to overcome their personal and tribal/cultural risks.

5.6.3. Environmental value

The new settlement will include wetland conservation and restoration, which will act as a buffer to the resettled community. This allows for the community to trap all rainwater and thus prevent it from running off and becoming surface water requiring storage and treatment. This is particularly valuable during average storm events, as surface water navigates quickly into nearby water systems once stormwater infrastructure reach capacity.

The project will also use permeable concrete surfaces, and develop extensive green spaces, rain gardens, and bioswales, among several innovative water management practices. Water capture is an effective management strategy because it yields multiple benefits. Water demand reductions from surface water supplies preserve existing hydrologic functions, benefiting downstream communities. Under storm conditions, mitigating surface water pollutants and recharging groundwater provides benefits wildlife habitat, water recreation, water quality, soil erosion protection, and prevents further subsidence of land. Water reductions also help local and state governments that are mandated to maintain streamflow requirements for habitat protection.

The Tribe's traditional relationship with natural products, such as the wood they fashion into boats could be part of a natural progression. Wood waste and bagasse from local sugar processing offer 'free' and abundant raw materials that can become a value-added product, producing a final product for sale or generating energy. The concept of developing relevant and appropriate local industry and the process leading to it will be shared in the educational instruction and tech transfer goals of the tribe for proactive solutions in a time of change. As the tribe has had to reduce its dependency on seafood harvesting with the loss of the bays and sheltered harvesting areas, new employment opportunities will make the community both economically resilient as well as structurally. The goal will be to have as self-sufficient a tribal community as possible committed to cultural re-invigoration and a model with elements useful for inclusion in the resettlement plans of other communities as such actions are warranted.

5.6.4. Social value

The proposal is centered on human rights, using indigenous knowledge and current science to ensure relocation and integration success and long-term generational viability. The tribe has assembled a multidisciplinary team spanning from cultural specialist, ethnobotanist, and anthropologist to planners, architects, and engineers to community organizers, strategic partners, and innovative financing and fund facilitators. These experts are able to collaborate in a sensitive and respectful manner with the tribe and across disciplines, as they have a high degree of shared subject matter of other disciplines. All have proven records of such inter-disciplinary engagement, as seen in their applied research and publications. The driving force behind resiliency is the tribe and its members who bring their own invaluable indigenous knowledge to the process – both cultural and ecological. The tribe will refine their own ecological knowledge, as they transfer them into a new ecology and community framework.

This project develops a new living environment for tribal members. The tribe will not only have access to improved quality housing, but greater access to cultural practices as a tribe. The space will provide opportunity to build a strengthen community ties and identity, while also improving outdoor recreational opportunities, with accompanied health outcomes. Therefore, this project will predominantly measure improvements in the living environment as a metric of social value. Improvements in living conditions will be measured through on-going participatory action evaluation by the residents with the core team, comparing their own experience of former living situations to current living situations. A participatory reflective evaluative process by the community helps the community appraise the functions of the environmental applications, modify and adapt when necessary for optimal benefit.

The social impacts of hurricanes can be devastating, particularly to a small community already impacted by subsidence and land loss. The economic value of protection from storms reflects the costs that could be measured through economic indicators, such as damage to built infrastructure or loss in revenue. However, many crucial impacts are not accounted for through economic indicators. These impacts include important gains or losses such as impacts to families, loss of place-of-home, and loss of cultural identity. Table 29 contains a variety of social phenomena linked to damage from Hurricanes. Resettlement to a less risk prone area would help mitigate some of these negative impacts.

Table 29. Social Phenomena Linked to Storm Damage

Social Phenomena	Methodology to Address	Source/Link to Data
Job Availability	Increased storm induced migration leads to temporarily saturated labor markets.	CRPC 2014 - Comprehensive Economic Development Strategy.
Access to Capital for Investment	Business uncertainty leads to a decrease in capital availability. Significant displacement of residents leads to business uncertainty.	Lavington, F. 1912. Uncertainty in its Relation to the Net Rate of Interest. Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans

Pressure on Social	Displacement due to hurricane damages leads to increased pressure on social services.	Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans:
Exposure to Disease	Evacuees of hurricanes see elevated rates of diseases.	Jablecki et al. 2005. Infectious Disease and Dermatologic Conditions in Evacuees and Rescue Workers After Hurricane Katrina
Access to Medical Care	Evacuees of hurricane Katrina reported poor access to medical care. Increased storm damage leads to more storm evacuees.	Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans
Mental Health and Therapeutic	Increased storm impacts lead to higher rates of PTSD, chronic health conditions and poor access to health care.	Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans Weems et al. 2010. Post Traumatic Stress, Context, and the Lingering Effects of the Hurricane Katrina Disaster among Ethnic Minority Youth
Community Cohesion	Increased levels of flooding lead to a lower proportion of residents returning to communities.	Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans
Availability of Housing	Destruction of housing led to increased costs for damaged and rebuilt housing deterring low income individuals from returning to the city.	Sastry, N. 2009. Tracing the Effects of Hurricane Katrina on the Population of New Orleans
Loss of Life	Damage due to storms is linked to loss of life via drowning, injury and trauma, and heart conditions.	Brunkard et al. 2008. Hurricane Katrina Deaths, Louisiana, 2005.
Crime and Violence	Couples experiencing impacts from hurricanes report increased levels abuse.	Schumacher et al. 2010. Intimate partner violence and Hurricane Katrina
Energy Security	Storm damage has affected oil and gas pipelines and other infrastructure in the past.	Grenzeback, L., & Lukmann, A. ca. 2006. Case Study of the Transportation Sector's Response to and Recovery from Hurricanes Katrina and Rita

Transportation Infrastructure	Storm damage has disrupted transportation infrastructure in the past.	Grenzeback, L., & Lukmann, A. ca. 2006. Case Study of the Transportation Sector's Response to and Recovery from Hurricanes Katrina and Rita

5.6.5. *Economic Revitalization*

The new settlement will provide economic opportunity and self-sufficiency outcomes for tribal members. The new lands will include opportunities for gardens, growing crops for sale, and value added agriculture (e.g. crawfish ponds), including the access to a commercial kitchen. Value added agriculture will provide the opportunity to serve the surrounding community with a green market, thus increasing the wellbeing of the larger area. The new settlement will also include commercial space for craft sales alongside tourist attractions associated with the tribe and cultural activities such as pow wows. The proposal will measure direct effects on a local economy by calculating the amount of income produced from enterprises and sales directly associated with facilities, opportunities, or land in the new settlement.

The planning phase will be an evolving process leading to potential business opportunities, including value added agriculture and seafood. This will require a market assessment for potential products, determination of capital investment options, assessment of raw material supply potential and a tribal branding study.

5.7. Challenges with implementation

5.7.1. *Political/stakeholder risks affecting implementation schedule*

Resettlement efforts can lead to a market flooded with home buyers and destabilize the local housing market.[41]

5.7.2. *Evidence of broad community support for proposal*

With Louisiana's coastline evaporating, it is imperative the state develop a resettlement model for lowland areas. Specifically, this model must be scalable, transferrable and must be mindful of cultural and social linkages defining a community. To this end, the state has partnered with a nonprofit, the Lowlander Center, and a local community – a band of Choctaw Native Americans in Isle de Jean Charles of Terrebonne Parish – to develop a resettlement model embodying the ideals of the LA SAFE resilience policy framework.

The IDJC Resettlement Project ("Project") is the culmination of almost two decades of effort by tribal leaders, working in concert with the present Project team. This Project seeks to produce a holistic plan, including and incorporating multi-disciplinary approach based upon indigenous knowledge and most recent scientific knowledge that will ensure a sustainable development – culturally, ecologically, socially and economically. The Project will focus on the following cornerstones of sustainable development provided by Ohio State University Sustainability Development Initiative[g]:

- Inclusion: Sustainability promotes inclusion of a broad base of stakeholders in community visioning, planning and implementation.

[g] http://comdev.osu.edu/programs/community-planning/sustainable-development

- Long-term: Sustainability takes a long-range perspective, looking out to future generations to insure that the decisions we make today do not cause harm.
- Interconnection: Linking and interconnecting social, economic and environmental goals so that all three spheres thrive in unison.
- Multidimensional: Development of measurements of success that link and balance social, economic and environmental goals of community.

Potential Partners

The Lowlander Center is providing for the State application the coordination of the team of collaborators for the tribe. It includes a variety of commercial and non-profit organizations, both local and national as well as OCD and CPRA staff. The lead architect/planner is indigenous, thus giving emphasis to the tribe's cultural values.

6. Project BCA: Coastal Non-Structural

6.1. Current situation and problem to be solved

Understanding that many communities face serious flood risks which will likely increase in the future, the State is pursuing a "multiple-lines-of-defense" strategy and investing in a combination of restoration, structural, and nonstructural projects to reduce coastal storm surge impacts. Knowing that structural projects such as levees alone will not suffice, nonstructural protection approaches offer additional methods to decrease flood risk in a dynamic coastal environment.

6.2. Proposal Description

6.2.1. Design philosophy

In general, structural protection reduces storm surge through the construction of physical barriers such as earthen levees or concrete seawalls, as well as pumps and floodgates. However, instead of blocking floodwaters, nonstructural protection offers an alternative to structural protection by accommodating floodwaters and either removing structures from harm's way or protecting buildings and infrastructure from flood damage through elevations and flood-proofing. Nonstructural projects are often beneficial in areas where structural protection is not feasible, cost-effective, or would have negative impacts on the environment. Additionally, nonstructural projects and policies can offer further protection in areas enclosed by levees. Both structural and nonstructural protection measures are part of a comprehensive "multiple-lines-of-defense" strategy, and when implemented in a complementary and coordinated manner will greatly reduce the risk of future flooding and economic damages for Louisiana's coastal communities.

6.2.2. Anticipated changes to local policies

Elevation of residential structures only is recommended in areas that have estimated 100-year flood depths between 3 and 14 feet based on risk assessment modeling for future flood risk conditions at year 50. As described above, these elevation heights include a higher safety margin than the 2012 Coastal Master Plan. The minimum required height will increase from one foot above the BFE to an elevation height based on BFE +2ft of freeboard. Nonstructural projects will be evaluated based on how well they reduce Expected Annual Damages (EAD) from flooding and how cost-effective they are. In addition, the State is including other evaluation criteria that capture communities' social and economic vulnerabilities, such as percent of population in the project area that is considered low to moderate income and percent of properties that are classified as severe repetitive loss.

7. Project BCA: Plaquemines Polder

Plaquemines Parish Government is pleased to propose this project to the Louisiana Office of Community Development/Disaster Recovery Unit for inclusion in the 2015 National Disaster Resilience Competition. The project, discussed in detail below, is critical to enhance regional resilience against flood risk, and long-term social and economic sustainability of the Louisiana coast. The Parish requests careful consideration of this project by the Louisiana Office of Community Development**.**

7.1. Overview of Benefit-Cost Analysis

Table 30: Overview of Benefit-Cost Analysis

Description	Quantity	Unit	Unit Price	Estimated Cost
Mobilization and Demobilization	1	JOB	$500,000	$500,000
Truck Wash-Down Rack	3	EA	$40,000	$120,000
Reinforcement Geotextile	100,000	SY	$6	$600,000
Clearing and Grubbing	1	JOB	$500,000	$500,000
Embankment, Compacted Fill	120,000	CY	$30	$3,600,000
Pointe Celeste Pump Station	1	JOB	$16,000.00	$16,000,000
Drainage Improvements	1	JOB	$750,000	$750,000
Seeding and Mulching	513.4	AC	$1,500	$770,100
Highway 23 Crossings	3	EA	$2,200,000	$6,600,000
Fertilizer	148,920	LBS	$3	$446,760
Right of Way	1	LS	$5,000,000	$5,000,000
Estimated Construction Cost				**$34,787,860**
20% Contingency				$6,957,572
10% E&D				$3,478,786
5% CM				$1,739,393
Total				**$46,963,6111**

This project already has significant stakeholder leverage. The Port of Plaquemines has committed $500,000 to the project if awarded the HUD resiliency grant. The Plaquemines Parish Government has already encumbered $3,000,000 towards the project and has committed an additional $3,000,000 if awarded the HUD resiliency grant. This represents the cost of the embankment, compacted fill placement. The Louisiana Department of Transportation and Development has committed $6,600,000 towards the project if awarded the HUD resiliency grant. This represents the cost of the Highway 23 Crossings. The Louisiana Coastal Protection and Restoration Authority has committed $9,000,000 towards the project if awarded the HUD resiliency grant. The New Orleans Regional Planning Commission has committed $2,000,000 towards the project if awarded the HUD resiliency grant. Therefore, the total requested to cover the project shortfalls is $22,863,611.

7.2. Current situation and problem to be solved

7.2.1. Critical, unique information beyond that described in OMB A-94

In 2011, US Army Corps of Engineers considered the alternative of tying sections of the Non Federal Levee System back into the Mississippi River Levees as part of the New Orleans to Venice Hurricane Protection Project. Initial studies were performed at various locations and it was found to be environmentally feasible to cross Highway 23 in order to close the system.

7.2.2. *What are environmental conditions in your area?*

The project is located on the west bank of the Mississippi River in Plaquemines Parish between Oakville and Diamond (Figure 1). This area lies in the delta of the Mississippi River approximately 15 miles south of downtown New Orleans. Barataria Bay, an estuary of the Gulf of Mexico, lies on the west side of the Mississippi River delta. The project area consists of a narrow strip of land enclosed by the NFL to the west and by the Federal Mississippi River levee to the east along the Mississippi River's west bank. The northern and southern bounds of the project area are the communities of Oakville and St. Jude, respectively. The project area extends on the flood-side of the NFL into the coastal marshes along the northeastern perimeter of Barataria Bay. It also extends east to include the Mississippi River. On the Mississippi River, the northern and southern project area limits correspond approximately to River Miles 70 and 46, respectively. LA-23 parallels the Mississippi River along the west bank and traverses the levee protected area.

7.3. Proposal Description

[Polders are low-lying tracts of land enclosed by embankments forming an artificial hydrological entity within which water would be pumped out. In Plaquemines Parish, two locations along the Mississippi's west bank – stretching roughly from Myrtle Grove to Port Sulphur – may be suitable for such implementations. Polders here would create development space coalesced around a vital economic corridor and would create a focal point for new development by which the parish may begin to reduce its overall footprint as land loss increases over time.]

7.3.1. *Key objectives*

The proposed project will enhance the regional resilience against flood risk by compartmentalization of the Plaquemines Parish flood protection system. Compartmentalization is a practical Dutch flood risk reduction strategy that protects critical functions in the flood-prone area and reduces the flood effects by dividing the area into compartments with the use of intermediate levees or dikes. Long-term social and economic sustainability of the Louisiana coast is also a fundamental objective of this project and is achieved by protecting Louisiana Highway 23 from inundation from minor storm events. All objectives fall under the basic five (5) root objectives:

1. **Reduce risk to public safety from catastrophic storm inundation.** The plan should ensure that LA 23, the main evacuation route on the west bank, is protected to the extent possible from Oakville to St. Jude.
2. **Reduce damages from catastrophic storm inundation**. Future economic damages to existing homes and businesses should be minimized through the implementation of nonstructural and/or structural measures.
3. **Avoid and minimize impacts to existing residential or commercial structures**. Any structural plan should avoid homes or businesses, or minimize such effects to the maximum extent practicable.
4. **Minimize impacts to existing stormwater drainage canals**. Because all structural plans proposed for this project will cross across or cover an existing drainage canal or ditch, it is critical that the plan provide a new drainage canal or ditch that extends to the existing pump station or any relocated pump station.
5. **Consistency with the State of Louisiana Master Plan for Coastal Protection and Restoration**. As shown in Table 1 below, this structural protection project is also consistent with the 2012 Coastal Master Plan objectives and principles on multiple fronts.

7.3.2. Design philosophy

Reducing Flood Risk for the Plaquemines Parish community is critical. The US Army Corps of Engineers has not been able to successfully provide the 50-yer Level of Risk Reduction with the current budget as previously intended. Due to cost over runs, unforeseen conditions, and delays the Level of Protection for the residents of Plaquemines Parish will fall short of the promised 2% storm event and this shortfall will have a dramatic effect on not only the residents but the business community as well. The Phillips 66 Refinery, an oil and gas refinery and a large employer of residents in the area, is located less than a mile from the south end of the NOV-NFL-04a polder. Highways 23 and 11 are the main access routes to the refinery and traverse through this polder. Protection of these highways is crucial because any down time of the refinery has significant local, regional, and national economic impacts. Down time of the refinery can be kept to a minimum by enhancing the protection of the infrastructure and other commercial facilities that support refinery operations. Increased LORR to the polder will facilitate this. Per the USACE calculations in their Risk Analysis Report for NFL system, the total estimated damage resulting from overtopping of NOV-NFL-04a levee reach alone is estimated to be $85M for a water-level of 9.0 ft. with an anticipated life loss ranging from 0.02 during day and 0.03 overnight. The total estimated damage resulting from overtopping of MRL-WB-179 levee reach is estimated to be $600M for a water-level of 17.5 ft. with an anticipated life loss ranging from 0.79 during day and 1.52 overnight. Similar figures have been determined for the entire Non Federal System of Plaquemines Parish.

This project will not only lower the estimated consequence of overtopping locally, it will have significant regional impact by potentially reducing the economic consequence of the Alliance refinery shut-down during a disaster, and lowering recovery times for the offshore oil & gas industry south of the area. The project will tie-in to the ongoing FEMA LAMP Pilot project in the Parish, and could contribute to further lowering insurance costs for residents. Since some of the Non Federal levee reaches are already under construction, an expedited approval and execution of this project could leverage significant cost savings since the construction grade of the levee sections is close (in some sections greater than) to the 100-year design elevation.

7.3.3. Main components of proposal plan

[The proposed project will upgrade the NOV-08 earthen levee reach between Fort Jackson and Venice in Plaquemines Parish to provide 100-year level of risk reduction (LORR). It will protect the residential and agricultural communities within this (approximately) 4,370 acre area, as well as protect existing wetlands and bottom growth hardwoods (refer to Figure 1). This will require *increasing the NOV-08* reach to a 100-year design elevation of 18 ft. No improvements to the ongoing fronting-protection construction project for the Duvic Pump Station (NOV-08b) will be included in the project as well as a portion of the NOV-08 levee system that was added to the current USACE design of NOV-7a (Empire to Fort Jackson) levee reach. The southern end of NOV-08a will tie in to NOV-15 floodwall at Childress & Venice, currently being designed (at elevation 17.5 ft.) as part of the NOV -11 , Buras to Fort Jackson levee reach design. Levee armoring and flood side berms are also being proposed given overtopping was identified as the key failure mode in U*SACE Risk Analysis* System.]

The following project attributes summarize the proposed polder closures at the four locations shown in Figure 1. The major features of the proposed project are highway crossings, levee enlargements and drainage features. All of the subpolders described in this report currently have active construction of the adjacent flood protection levees.

La Reusitte Subpolder Closure:

NOV-NFL-04a: This reach includes approximately 8.5 miles of back levees from Oakville to La Reussite on the west bank of the Mississippi River. This levee has existing crest elevations ranging roughly from 4.5 ft. to 8 ft. The return frequency for a storm surge associated with the low elevation is below 30-year LORR. The crest width of the levee varies throughout the reach. The current levee footprint roughly takes up 62 acres.

USACE is currently raising specific sections of NOV-NFL-04a levee reach using a combination of flood side and protected side alignment shifts for increased flood protection. The construction also includes a combination of protected side slopes (varies between 1V:3H to 1V:6H) and flood-side slopes (varies between 1V:4H to 1V:7.25H), degradation of existing levee, and both flood-side and protected-side berms depending on the levee sections. The levee sections are being constructed in 2 stages to allow the new levee embankment to settle prior to placing the final embankment. The Stage2 construction grade of the levee will vary between 8.0 ft. – 13.0 ft.1 The intent is to maintain a crest elevation that raises the levee sufficiently to ensure a 9.0 ft. 50-year design elevation is maintained 10 years after completion of construction.

MRL-WB-179: This reach includes 6 miles of Mississippi River Levee (MRL) with a crest width of 10 ft. and levee slopes of 5H:1V on the flood side and 3.5H:1V on the protected side. The crest height for the reach is generally an elevation of 17.0 ft. but may have slight variances. The level of protection for a storm surge associated with the lowest elevation is less than a 100-year LORR. The existing levee footprint roughly takes up 59 acres.

Proposed Closure Levee: The proposed polder closure will follow the existing Parish levee which is currently used to flood fight during storm events. The total length of the polder closure is approximately 1,000 LF. The closure will require the raising of Highway 23 as well as Highway 11. The existing railroad crossing will remain open and will be flood fought during storm events.

Lake Hermitage Subpolder Closure:

NOV-NFL-05a: This reach includes approximately 8.5 miles of back levees from Oakville to La Reussite on the west bank of the Mississippi River. This levee has existing crest elevations ranging roughly from 4.5 ft. to 8 ft. The return frequency for a storm surge associated with the low elevation is below 30-year LORR. The crest width of the levee varies throughout the reach. The current levee footprint roughly takes up 62 acres. Reach NOV- NF-05 is an earthen levee constructed by the local interests and begins near La Reussite where the freshwater diversion outlets flow into the marshland, and follows a south easterly track to Myrtle Grove and ends along Highway 23 approximately 1.5 miles downstream of the Plaquemines Parish Sheriff's shooting range. The existing levee is an earthen levee with a 10-foot crown width and elevations ranging from about 2 to 9 feet, with a median height of 5.2 feet. The total length of the back levee within NF-05 is approximately 14.3 miles, with a perimeter of roughly 21 miles including the associated MRL length, when using a temporary closure at Lake Hermitage Road, which includes approximately 2.5 miles of levee south of the Myrtle Grove Marina that is mostly privately owned and maintained. The leveed area includes the Conoco Phillips refinery (a major employer in the Parish with a workforce of about 400 people), a coal stock pile yard, and open pasture lands. The levee provides risk reduction for approximately 5,500 acres and the land drains in a westerly direction from Highway 23 to landside canal that carries the local drainage to the Wilkinson Canal pump station to the south of the Myrtle Grove marina

MRL-WB-178: This reach includes 6 miles of Mississippi River Levee (MRL) with a crest width of 10 ft. and levee slopes of 5H:1V on the flood side and 3.5H:1V on the protected side. The crest height for the reach is generally an elevation of 17.0 ft. but may have slight variances. The level of protection for a storm surge associated with the lowest elevation is less than a 100-year LORR. The existing levee footprint roughly takes up 59 acres.

Proposed Closure Levee: The proposed polder closure will extend from the proposed NOV-NF-06a.1 levee to the Mississippi River Levee. The total length of the polder closure is approximately 1,500 LF. The closure will require the raising of Highway 23 but does not cross any existing railroad crossing. Impacts to bottomland hardwood is expected.

Pointe a la Hache Subpolder Closure:

NOV-NFL-06a: This reach begins where Reach NF-05 ends, next to Highway 23 at the downstream end of the International Marine Terminal's coal stockpile yard. The existing levee alignment is approximately 12 miles, nearly 9 miles of which runs south away from Highway 23 along the west side of the Citrus Lands and turns back up to Highway 23 just upstream of West Pointe a La Hache. The remaining 3 miles to reach the NOV tie-in includes a 1-mile length of privately maintained levee that has a height of roughly 4 feet and protects a Plaquemines Parish maintenance building and equipment (Figure 2-7), and a 2-mile section that currently does not have a levee (Figure 2-9). The existing levee is an earthen levee with a 10-foot crown width and elevations ranging from about 3 to 11 feet, with an overall median height of 4.9 feet. The perimeter of NF-06 measures over 22 miles when including the associated MRL length and provides risk reduction for approximately 5,000 acres of primarily pasture and agricultural land. It includes pump stations at Point Celeste and Pointe a La Hache West that will require fronting protection

MRL-WB-177: This reach includes 6 miles of Mississippi River Levee (MRL) with a crest width of 10 ft. and levee slopes of 5H:1V on the flood side and 3.5H:1V on the protected side. The crest height for the reach is generally an elevation of 17.0 ft. but may have slight variances. The level of protection for a storm surge associated with the lowest elevation is less than a 100-year LORR. The existing levee footprint roughly takes up 59 acres.

Proposed Closure Levee: The proposed polder closure will extend from the proposed NOV-NF-06a.3 levee to the Mississippi River Levee just south of LaCrosse Lane. The total length of the polder closure is approximately 990 LF. The closure will require the raising of Highway 23 but does not cross any existing railroad crossing. This polder will also require upgrades to the existing Pointe Celeste Pumping Station which is currently in a state of disrepair (Figure 2). Through coordinated efforts between the Parish and the US Army Corps of Engineers, ongoing plans for the fronting protection for the Pointe Celeste Pump Station were adjusted to account for the proposed future replacement of the Pumping Station. Incorporating the required blockouts for the proposed discharge pipes will lead to significant cost savings for the Parish.

Diamond Subpolder Closure:

NOV-05a: This reach includes approximately 3.3 mile of back levees from St. Jude to City Price on the west bank of the Mississippi River. This levee has existing crest elevations ranging roughly from 7 ft. to 10 ft. The return frequency for a storm surge associated with this low elevation is below a 20-year LORR. The crest width of the levee throughout the reach remains constant at 8 ft. However, the slide slopes vary at the north end of NOV-05a and highway 23 crossing from 4H:1V upstream to 3H:1V below the crossing. The existing levee footprint takes up roughly 81 acres.

USACE is currently raising the NOV 5a levee for increased flood protection (10% complete), including a combination of 1V: 3H protected side slope and flood-side shift without degrading existing levee. The construction grade of the levee will vary between 15.0 ft. – 18.5 ft. (including overbuild). The intent is to maintain a crest elevation raised sufficiently to ensure the 13.0 ft. 50-year design elevation is maintained 10 years after completion of construction. The crown will be 10-ft wide, flood-side slope of

1V:6H and protected side slope of 1V:3H. The construction will consist of 2 stages to allow the new levee embankment to settle prior to placing the final embankment. This project will provide a 50-year LORR to the communities on the protected side of this levee reach.

NOV-09: This levee reach is authorized for construction to a 50-year LORR and identified as requiring "High Priority Repairs" by USACE. This reach includes 3-miles of Mississippi River Levee (MRL) with an existing crest width of 8 ft. and levee slopes of 3H:1V on the flood side and 3.5H:1V on the protected side (there is no wave berm on the flood side). The crest height at the upstream end has an elevation of 15.5 ft. and generally declines to an elevation of 14.5 ft. at the downstream end. The lowest elevation is approximately 14 ft. The level of protection for a storm surge associated with the lowest elevation is less than a 20-year LORR. The existing levee footprint roughly takes up 29 acres.

Proposed Closure Levee: The proposed polder closure will follow the historic, local levee closure which is currently used to flood fight during storm events but was breached during the construction of Highway 23. The total length of the polder closure is approximately 700 LF. The closure will require the raising of Highway 23 as well as retrofits/replacement of the existing sluice gate drainage culvert.

7.4. Risks if proposal is not implemented

7.4.1. Realistic expectations in 5, 20 and 50 years if proposal is not implemented

Modeling the future impacts of tropical storms on Plaquemines Parish is relatively difficult. While planning teams have been able to model potential storms, it is much more difficult to predict when such storms will occur and what the impacts will be. Some sources point to rising sea level and water temperature as signs that damaging coastal storms will become larger and more frequent. As sea levels rise, coastal flooding from tropical storms could cause more extensive damage than storms today because the sea level will already be higher to begin with.

While of the whole Parish is vulnerable to the impacts of tropical storms, the most vulnerable populations are living outside of the Belle Chasse area and outside of the protection system. This is one more reason for further investment in the resiliency of these historic communities. The following table illustrates a summary of the population that lives in areas greater than and less than 5 feet above sea level. The overwhelming majority of the population of Plaquemines Parish is located in areas lower than 5 feet above sea level. Of the population living in areas below 5 feet of elevation, 30% are minority, 28% are under the age of 18, and 10% are elderly. The population living in these areas is most at risk of sea level rise and subsidence over the coming years.

Table 31: Vulnerability by Elevation

	5 feet or Greater	Less than 5 feet
Total	2,338	20,704
White	1,697	14,549
Minority	641 (27%)	6,155 (30%)
Age 18+	1,801	14,912
Children	537 (23%)	5,792 (28%)
Seniors	433 (19%)	2,144 (10%)

7.4.2. *Impact on community as whole if proposal is not implemented*

Plaquemines Parish is located at the mouth of the Mississippi River, home to the most combined land and water area in the state of Louisiana and is the State's southernmost parish. The parish is 2,429 square miles, of which 845 square miles is land and 1,584 square miles is water. It is part of the New Orleans Metropolitan area and is thus bordered by Jefferson Parish to the west, Orleans Parish to the north, and St Bernard Parish to the northeast. The remainder of the Parish opens to the Gulf of Mexico. Plaquemines Parish is located within the New Orleans Metropolitan Area, and as such contains some suburban communities such as Belle Chasse, which contain the majority of the Parish's population. The Parish is 29% minority and 71% white, with 11% of the population living in poverty. The rate of population that does not speak English is very low at 3%, and the elderly population is relatively low at 11%. The minority population and population living in poverty are overwhelmingly located outside of the 100-year levee system of Belle Chasse. The proposed project features outlined in the proposal focus on those most vulnerable communities that do not have proper flood protection against even minor surge events.

As mentioned above, Plaquemines Parish is vulnerable to a number of hazards. Below is a summary of past hazard events in Plaquemines Parish, including damage estimates and injuries.

Table 32: Summary of Past Hazard Events in Plaquemines Parish

	Events	Injuries	Property Damage	Crop Damage	Annual Probability	Damage/Event
Cold/wind chill	3				5%	
Drought	2			$250,000	3%	$125,000
Flash Flood	7		$130,000		11%	$18,571
Funnel Cloud	1				2%	
Flood	8				13%	
Hail	16				25%	
Heavy Rain	2				3%	
Heavy Snow	1				2%	
High Wind	1				2%	
Tropical Storm	21		$1,543,141,000		33%	$73,482,905
Lightning	1				2%	
Storm Surge/Tide	6		$1,000,105,000		9%	$166,684,167
Thunderstorm	67		$579,000		89%	$10,167
Tornado	30	11	$690,000		47%	$23,000
Winter Storm	1			$50,000	2%	$50,000

Grand Total	**157**	**11**	**$2,544,645,500**	**$300,000**		**$16,209,525**

8. Project BCA: St. John Multimodal Transit

8.1. Current situation and problem to be solved

St. John the Baptist Parish sits on either side of the Mississippi River on high, strong ground between the major metropolitan areas of New Orleans and Baton Rouge. However, as the parish has developed, homes and businesses have sprawled towards Interstate 10 into the floodplain. Hurricane Isaac and other similar storms have brought these development patterns into sharp focus as a critical issue, causing repetitive flood losses for current residents and hindering future growth in the parish. As coastal communities erode and become progressively unsafe places to live, St. John becomes a more relatively attractive place to live in Louisiana. To make sure that St. John has the capacity to absorb residents from coastal parishes as well as accommodate all its current residents in a safe and resilient manner, this project focuses on reshaping the LaPlace area to become more attractive to development through a smarter regional transportation system. This project's activities include a multimodal transportation center that can double as a resilient disaster shelter and staging area, as well as a long-range transportation and smart growth plan.

8.2. Proposal Description

In September 2014, the St. John Parish Planning Commission adopted *One Parish, One Future: the St. John the Baptist Comprehensive Plan*. This plan establishes parish-wide priorities for infrastructure improvements and a future land use map. The NDRC process provides an opportunity for Parish stakeholders to elaborate on the broader transportation and land use strategies within the comprehensive plan, and to reinforce resilient development patterns.

Specifically, the implementation targets the development of two transportation depots, one in Reserve and one in Laplace within the context of the creation of a larger public transportation system. Additionally, it should be noted that a depot in Laplace would coincide with a terminal stop for a future commuter rail system connecting Baton Rouge and New Orleans.

8.2.1. Key objectives

The objectives of this effort are to: 1) improve connections between residents' homes and destinations in the parish via alternatives transportation; 2) concentrate future land use development in strategic areas that are less vulnerable to natural disasters; and 3) Leverage existing and planned transportation assets to bolstMain components of proposal plan

[The following strategies are proposed to achieve the stated objectives: 1) develop an intermodal transportation terminal and plan for transit-oriented development; and 2) plan for Long-Term Public Transportation Needs and Land Use Opportunities.]

Intermodal transportation terminal and plan for transit-oriented development

[A coalition of state and local economic development and transit champions are currently working to establish a commuter rail corridor between Baton Rouge and New Orleans. The route as planned will include a dedicated stop in Laplace. Quick rail service from this location to the job centers in either city will generate significant opportunity to create new homes on high ground with strong local and regional connections. Through the NRDC initiative, the Parish will plan for a multimodal transportation terminal and optimize its regulations governing land use and development form in a transit-oriented development zone surrounding the terminal site. This effort will ensure the Parish fully leverages and equitably distributes the significant public investment for the rail corridor.]

[The proposed site for the intermodal terminal is an approximately 4.5 acre parcel located between the current Kansas City Southern railroad and West Airline Highway, upriver from Main Street, in central Laplace. The site is owned by a single entity.]

[The terminal at this site would not only facilitate transfers between rail, bus and automobile modes, but also serve as a disaster response site to house emergency operations. It will include the following components: commuter rail waiting and boarding area; demand-response and fixed-route bus waiting and boarding area; indoor waiting area; solar energy system including energy storage, to provide power in the event of an outage; flexible indoor space that may serve as an emergency shelter, staging area for disaster supplies, rental space to generate operating revenue, retail or concessions space to generate operating revenue, or a parking lot.]

Peer multimodal transportation centers (see Table 33) have ranged in size from 9,500 square feet to up to four city blocks.

Table 33: Peer Multimodal Transportation Centers

Project and Location	**Athens, GA Multi-Modal Transportation Center**	**Uptown Station, Normal, IL**	**Meridian Multi-Modal Transportation Center, MS**	**Rosa Parks Multi-Modal Transportation Center, Lafayette, LA**
Size	9,500 SF	68,000 SF	Four city blocks	40,000 SF
Year Complete	2007	2012	1997	2007
Cost	$9.5 million	$47.4 million ($35 million for building construction)	$6.5 million (1997 dollars)	$11 million (building renovation)
Funding	Voter approved, dedicated local sales tax	$22 million TIGER grant, $13 million state and local funding, FTA Grants (bus and bus facilities program), Dept. of Commerce and Economic Opportunities Grants, local bonds, TIF district established to pay for infrastructure improvements and other nearby	$5.1 million from Federal and State grants (ISTEA); $1.3 million from the City; $431,000 from Amtrak; Local Certificates of Participation (COP’s) - state authorized funding that allows non-profits to lease their facility, then sell shares to financial institutions; Special events held on site; Union Station ‘Patron’s Club’, which sells brick pavers and recognition	Federal Transit Administration, LA Department of Transportation and Development, $850,000 from Lafayette Public Trust Financing Authority

		redevelopment. Retail lease.	plaques; Conference and reception room rental	
Annual ridership and modes	1.7 million riders annually. Athens Transit System (local), University of Georgia Transit System (local), Megabus (regional), access to Oconee River Greenway, designed for eventual link to rail service	Amtrak: 245,000 annual riders. Connect Transit (regional bus service to Bloomington), bus tours, taxis, connections to bike trails	242,360 total users/yr; Amtrak passengers: 11,500/yr. Norfolk Southern, Greyhound, Meridian Transit System (demand response only)	Amtrak, Greyhound, City of Lafayette Transit
Amenities	Climate controlled waiting area, bike storage, information center, office space, a pedestrian bridge connecting the transport center with a 646 space parking structure shared with the a convention and performing arts facility. A polling location.	Includes municipal offices, the Mayor's office, City Council chambers, community meeting rooms, 380 space parking garage, free wi-fi, sheltered bike parking. 7,500 sq.ft of retail space, including a Subway restaurant	Complex includes community meeting rooms, Meridian Railway Museum, East Mississippi Development Corporation, Arts and Entertainment Museum	Offices for Parish Traffic and Transportation Department, post office, AOC Community Media (public access television station), hosts government meetings

Plan for Long-Term Public Transportation Needs and Land Use Opportunities

The expansion of the energy and petrochemical manufacturing industry in southeast Louisiana is expected to create thousands of new jobs over the next several years in the River Parish region of St. John the Baptist, St. James and St. Charles Parishes. For instance, Formosa Petrochemical is exploring a production complex near Gramercy that would create 1,200 direct jobs and 8,000 indirect jobs, according to Louisiana Economic Development; hiring would begin in 2018.[h]

While the planned commuter rail will help St. John Parish residents access existing jobs in Baton Rouge and New Orleans and their suburbs, many of the new energy jobs will be located in difficult-to-access locations that the railroad will not serve. Providing workers access to these job locations will be critical to these communities' prosperity and resilience. However, St. John Parish and its neighboring

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[h] New Orleans CityBusiness "$9.4B ethylene plant in St. James Parish proposes thousands of jobs" http://neworleanscitybusiness.com/blog/2015/09/03/9-4b-ethylene-plant-in-st-james-parish-proposes-thousands-of-jobs/. Accessed 22 September 2015.

communities lack frequent, reliable and convenient transportation choices, and face several barriers to traveling within and outside the region.

Since the Edgard/Reserve Ferry ceased operations in 2013, the only way St. John Parish residents can cross the Mississippi River is via the Gramercy Bridge – a 20 mile journey from Reserve to Edgard. In the ferry's absence, the River serves as a significant barrier to intra-Parish and regional connectivity. Because jobs and amenities are concentrated on the East Bank, the loss of the ferry disproportionately impacts West Bank residents. Moreover, West Bank land is less vulnerable to flooding than that on the East Bank.

Meanwhile, existing transit service, provided by the River Parish Transportation Authority, is limited. RPTA does not offer fixed-route service, and demand-response service must be requested in advance. RPTA operates just three vehicles at peak service during the week and two vehicles on the weekend. Ridership is very low; in 2014 riders made 16,636 trips, equaling approximately 1.5 riders for every hour that a vehicle was on the road. The agency is primarily geared toward serving an economically distressed ridership that often have serious medical needs that limit their mobility and access to transportation alternatives. As St. John the Baptist Parish grows, it will be important to develop a transit system that will be attractive and useful to the broader community.

The planned commuter rail, imminent job boom and lack of a coordinated and comprehensive transportation network warrant a comprehensive transportation and land use planning process. Specifically the plan will:

1. Convene regional stakeholders such as employers, workforce training organizations, government officials, and residents, to ensure the development of a publicly supported, shared vision for effective public transportation and associated land use development;
2. Identify key transit corridors and evaluate costs and benefits of each;
3. Determine procurement, fleet management, technology and other operational needs;
4. Identify opportunities for transportation oriented development, particularly in relation to the new commuter rail terminal; and
5. Develop a phased implementation plan and funding strategy

The following sections summarize our understanding of the costs of expanded transportation choices.

8.2.1.1. Edgard/Reserve Ferry Concept, Costs and Benefits

In fiscal year 2013 (July 1, 2012 – June 30, 2013), the State expended approximately $2.3 million in operating and maintenance costs to run the ferry. A $1 fare charged to motorists crossing toward the West Bank only generated $85,475 –3.7% of the total revenue. The state's Transportation Trust Fund provided the remaining funds. During this year, the ferry served 209,137 one-way vehicle trips and 2,565 one-way pedestrian trips. In April 2013, an 450 vehicles and 15 pedestrians made round trips each day the ferry was in service. Table 34 itemizes the ferry service's revenues and expenses.

Table 34: Reserve-Edgard Ferry FY2012-2013 Budget

Revenues	
Self Generated - Ferry Tolls	85,475
Self Generated - Bridge Tolls	0
Self Generated - Scripts	2,164
TTF - Regular	2,235,277

Estimated Total Revenues	**2,322,916**
Expenditures	
Regular Salaries	669,131
Overtime	186,851
Termination Pay	1,030
Related Ben. 45%	213,529
Travel	1,795
Operating Services	12,664
Supplies	255,462
Other	507
Total Direct Expenditures	**1,340,968**
Other Ferry Costs (Capital & Maint. - Overhead divided on % by type of crossing)	
Insurance	380,678
Capital - Drydock/Major Repairs	345,000
Maintenance	256,270
Total Other Ferry Costs	**981,948**
Total All Ferry Costs	**2,322,916**
Annual Traffic (Vehicles)	
Vehicles	209,137
Pedestrians	2,565
Average Cost Per Vehicle	$11.11
Average Cost Per Pedestrian	N/A
Average Subsidized Cost Per Vehicle	$10.69
Annual Crossings	14,686
Average Cost Per Crossing	$158.17

Source: LADOTD

During this year, the ferry operated Monday through Friday from 5am to 9pm – about 4,160 annual revenue hour of service. This results in about $322 per revenue hour in operating costs only.

While the precise origins and destinations of these trips are unknown, a rough estimate may be made of the additional cost imposed on them by analyzing the cost of the 20-mile, 25-minute detour to cross the Gramercy Bridge, upriver in St. James Parish. At an average operating cost of 17.18 cents per mile, each one way trip adds $2.94 to a vehicle trip cost – about $614,026 annually.[i] This extra ten minutes added to each journey results in a total of 35,283 hours of additional trip time.[j]

8.2.1.2. Fixed Route Bus Service Concept, Costs and Benefits

Fixed route bus service offers a good option to providing better transportation in St. John the Baptist Parish because it offers greater capacity than the existing demand-response service, and can evolve in the coming years to adapt to the changing needs of the parish. Phase 1 of this service should be limited to a key corridor where a high quality of service can be offered at a reasonable price and reach the most important destinations in the parish. **Error! Reference source not found.** offers an example of a simple route connecting the key commercial corridor of Airline Highway in LaPlace to South Central Louisiana Technical College campus and neighborhoods in Reserve. **Error! Reference source not found.** shows how in the future a bus route could be created to accommodate the implementation of ferry service between Edgard and Reserve. Finally **Error! Reference source not found.** shows how transit routes could be adjusted to account for rail service to LaPlace and future growth on the west bank of St. John the Baptist Parish.

Table 35: Assumptions made in preparation of revenue and cost of transit phases.

Assumptions	Value
Annual Inflation	2.5%
Hourly Cost	$80
Fare	$1.50
Daily Service Span	14
Days of Service	250
State Operations Funding	3.0%
Federal Operations Funding	20%
Federal Capital Funding	80%

The scenarios and figures presented to describe the phases of transit are merely illustrations of the concept discussed in this section. The parish today does not have the land use patterns and density to support high transit ridership, but it would be beneficial to introduce the concept and incrementally improve transit options as land use evolves to promote more ridership.

The phases presented below are furthermore based on a number of general assumptions that can be adjusted over time to improve the accuracy of costs, revenues and ridership estimates. The first major assumption is that service will continue to cost about $80 for every hour of service provided. This is approximately the compensation rate for the current third party, private operator of service for RPTA. The Federal funding for operations and capital expenses is another key assumption. The Federal Transit Administration (FTA) will generally provide grants in rural and small urban areas to fund operations with a 50% local match. However, those funds are usually capped at a relatively small percentage of the agency's operating costs. It varies from one transit agency to the next, but 20% is a fair approximation of

[i] The average operating cost per mile includes gas, maintenance and tires, excludes vehicle ownership costs, subtracts the 50 cent one-way fare, and is based on a medium sedan. *Source: American Automobile Association, Your Driving Costs, 2015.*

[j] This estimate assumes pedestrians will carpool with motorists using the ferry.

how much operating funds RPTA could expect to receive from the FTA for the proposed, additional service. Next there is an assumption that new fixed route buses will cost about $350,000. This price is typical for a low-floor 30’ bus that will provide a very high quality customer experience and resemble other fixed route buses that operate in the New Orleans metropolitan area. These assumptions are based on existing conditions and will need to be monitored going forward as the outlook for federal funding and regional growth potential are constantly changing.

Table 36: Transit service could be introduced in the short term and expand to meet the growing need of St. John Parish.

	Phase 1 - 2015	Phase 2 - 2025	Phase 3 - 2040
Number of Buses	2	4	7
Year	2015	2025	2040
Platform Hours	7,000	14,000	24,500
Route Miles	18	23	215
Average Headways (minutes)	30	37.5	47
Riders per hour	8	12	16
Annual Ridership	56,000	168,000	392,000
Daily Individual Riders	118	354	825
Sources of Operating Funds Expended	$560,000	$1,433,695	$3,633,730
Federal	$95,200	$222,223	$508,722
State	$16,800	$43,011	$109,012
Local	$364,000	$845,880	$1,925,877
Fare Revenue	$84,000	$322,581	$1,090,119
Additional Capital Cost	$1,400,000	$2,688,178	$5,839,924
Federal	$1,120,000	$2,150,542	$4,671,939
State	$0	$0	$0
Local	$280,000	$537,636	$1,167,985

9. BCA Project: St. Johns Resilient Housing

9.1. Current situation and problem to be solved

[St. John the Baptist Parish Housing Authority’s manages 260 Section 8 vouchers and 296 public housing units over 4 communities throughout the Parish. The LaPlace (116 units), Reserve (92 units) and Garyville (54 units) communities are located on the east side of the Mississippi River. The Edgard site (34 units) is located on the west side. Of the 296 total units; 196 are vacant due to age and storm damage. Additionally, the communities do not meet current ADA standards nor do they provide modern unit or community amenities.]

[In May 2013, the Parish published its Community Recovery Strategy, which highlights the concerns and priorities of the Parish officials and its residents. As set forth in the report, the highest priority is to upgrade the Parish infrastructure; drainage, roads, and water are at the top of the list, and preservation of the ferry service is another important priority.]

[The strategy also noted a substantial need for affordable housing available within the Parish. As a result of Hurricane Isaac, there is a currently a shortage of safe, sanitary, and decent housing available. This is borne out by the fact that fewer than half (43 percent) of the 936 households that received FEMA assistance due to the storm were able to find appropriate housing accommodations within the Parish. Of the 3,328 rental units in the Parish, 1,475 were damaged by the storm, and almost 70 percent of these were in LaPlace.]

[The need for affordable housing is evidenced by the great demand for the Housing Authority's Section 8 voucher program. The Authority has 260 vouchers issued and the wait list, last updated in November 2014, contains 4,721 families on it who need housing assistance. SJBPHA baseline of 260 vouchers is insufficient to address the demand of individuals and households in need of affordable housing.]

9.1.1. What are environmental conditions in your area?

[St. John the Baptist Parish sustained significant damage in 2012 from Hurricane Isaac and the public housing units were not spared. Virtually all of the roofs were damaged and, 3 years later due to lack of funding, are still in need of repair, thus causing deeper water damage to the buildings. Additionally, while the Authority's communities are not within flood prone areas, slab settlement and poor internal infrastructure caused many of the apartments to flood during the storm. Ultimately, Hurricane Isaac damaged 211 of units.]

[The Authority received $485,000 in insurance proceeds in 2013 from Hurricane Isaac assessed damage. Additionally, FEMA assessed $292,698.21 in value for storm related damages. The Authority is in the process of requesting an increase of FEMA funding to match the damage truly sustained and will then move towards officially applying to FEMA for use of the funds. Currently, the Authority is utilizing available funding to bring minimally damaged units back into service; however, the rehabilitation and remediation costs noted in recent Physical Needs Assessments far exceed funds received from insurance or FEMA. As a result, the Authority has embarked on a Transformation Plan that will help bring its storm damaged units back online, leverage the funding and assist in meeting the affordable housing needs of the Parish.]

[Specific geographies have been identified for future population and economic growth based on anticipated future flood risk. Specifically, both the east and west banks of the Mississippi River in St. John are projected to experience minimal future flood risk, including the communities of Laplace, Reserve, Edgard and Garyville. In order to maximize this future growth opportunity, these underutilized territories must reconsider their current housing stock and construct new, forward-thinking housing developments to both meet current demand for affordable housing and incentivize future growth within high-ground corridors.]

9.2. Proposal Description

[One component of the parish's needed housing transformation is the LaPlace Redevelopment located in the LaPlace community. Currently, the Authority's LaPlace community contains 116 units, 86 of which were damaged by Hurricane Isaac and only 51 of which are currently occupied. The 10 acre site is walking distance to the major commercial district in LaPlace as well as major transportation routes through the Parish including Airline and River Road. LaPlace Redevelopment will contain 125 newly constructed units across 8 'stacked flat' building types. The Housing Authority and Columbia Residential held a design workshop attended by x # of residents, neighbors, Parish leadership and community leaders in August 2015. The input from this meeting included preferences for a walking trail, outdoor bar-b-que area, playground and indoor fitness area as well as a more cottage style exterior, porches and 'eyes on the street and playground area' so the community can stay safe. These desires are now reflected in the site plan. It is anticipated amenities will include: a fitness center, playground with walking trail surrounding it, a business center, a large community room, and several sitting/gathering areas inside and outside. In unit amenities will include: fire suppression canisters over the range, pressurized Fire Sprinkler System, Security Systems and Energy Star Certified appliances including a dishwasher, range and refrigerator. All buildings will be certified green buildings to ensure lower water and power bills as well as healthy indoor air quality for residents. Additionally, the site contains several large live oak trees the design protects from construction activity and utilize as a grand entryway to the revitalized community.]

9.2.1. Key objectives

The Housing Authority has a commitment to improve the living conditions of its residents and is launching a Housing Transformation effort that will set an example for high quality multifamily, mixed income housing that is more resilient in its location and construction than anything in the Parish today.

9.2.2. Main components of proposal plan

In 2014 the St. John the Baptist Parish Housing Authority issued an RFQ for a developer partner and Columbia Residential was selected to assist in redeveloping the Housing Authority's portfolio. Columbia Residential has a 24 year successful track record of mixed-income housing and public housing transformations in New Orleans, Louisiana, Atlanta, Columbus, and Athens, Georgia. Together, Columbia Residential and the Housing Authority create a uniquely qualified and exceptional team with master planning, development and finance experience, design team expertise, human capital and philosophical commitment.

The team has identified five phases of development: four at existing housing authority sites and one offsite. The Authority's existing funds will be leveraged with a mixture of 4% & 9% Low Income Housing Tax Credits, local Parish funding, HOME program funding, Federal, state and local grants, private lending, as well has local community support.

The transformation intends to strategically redevelop all the public housing units with new construction. The Authority and Columbia Residential are already working with current residents, community leaders, Parish leaders and organizations to help envision, set goals and craft a transformed community that provides high quality workforce housing for the Parish, market rate housing and public housing integrated seamlessly together with supportive services and amenities.

The Garyville Redevelopment is progressing forward as a 9% Low Income Housing Tax Credit application in 2016, leveraging Parish CDBG funds as it transforms a 54 unit development housing 17 public housing families into a 73 unit community with a mixture of public housing (either ACC or RAD conversion), tax credit and market rate units.

The LaPlace Redevelopment contains 116 units, 86 of which were damaged by Hurricane Isaac and only 51 of which are currently occupied. The 10 acre site is walking distance to the major commercial district in LaPlace as well as major transportation routes through the Parish including Airline and River Road.

LaPlace Redevelopment will contain 125 newly constructed units across 8 'stacked flat' building types. The Housing Authority and Columbia Residential held a design workshop attended by x # of residents, neighbors, Parish leadership and community leaders in August 2015. The input from this meeting included preferences for a walking trail, outdoor bar-b-que area, playground and indoor fitness area as well as a more cottage style exterior, porches and 'eyes on the street and playground area' so the community can stay safe. These desires are now reflected in the site plan. It is anticipated amenities will include: a fitness center, playground with walking trail surrounding it, a business center, a large community room, and several sitting/gathering areas inside and outside. In unit amenities will include: fire suppression canisters over the range, pressurized Fire Sprinkler System, Security Systems and Energy Star Certified appliances including a dishwasher, range and refrigerator. All buildings will be certified green buildings to ensure lower water and power bills as well as healthy indoor air quality for residents. Additionally, the site contains several large live oak trees the design protects from construction activity and utilize as a grand entryway to the revitalized community.

The plan is evolving, but currently we intend to redevelop the currently occupied units in 1:1 ratio and have the unoccupied turned into vouchers if possible via a longer conversation with HUD. It may be more detail and trouble to go into here than needed.).

The communities within this Transformation of Housing will be more resilient to future storms and conducive to a more financially, environmentally and equitably sustainable community by: replacing severely distressed low-income housing that was damaged during storms with high quality construction utilizing hurricane / high wind construction techniques; increasing residential density in the Parish's high grounds; utilizing national or regional green building and community certifications appropriate for the region and climate zone and verified with 3rd party agencies; creating workforce housing for growing Parish economy near current and future job centers to reduce commutes and allow for workers to return to work more quickly after a storm event; housing seniors in long-term high quality, independent living so residents of the Parish can age in place within their existing social networks; and supporting residents as they learn about the green construction techniques of their building and community and how their new homes may function differently. This will include green living manuals and trainings for residents and property management.

10. Appendix A: Description of Ecosystem Service Concepts and Methodologies

10.1. Description of Ecosystem Service Concepts

The MEA lays out four broad categories: provisioning, regulating, supporting and information services. These categories are defined below, with direct examples from the Mississippi River Delta region provided to illustrate the forms that ecosystem services take within the context of this report.

1. ***Provisioning services*** provide ecosystem goods. For example, in the Delta, the Barataria Basin provides oysters, black drum, and other fish. The Mississippi River provides fresh water for New Orleans and other coastal communities. Provisioning goods are often traded in markets and they are familiar and easy both to physically quantify and to value monetarily through direct market transactions.

2. ***Regulating services*** are benefits obtained from the natural control of ecosystem processes. Healthy ecosystems regulate water quality, climate, storm impact, and soil formation, and they also keep disease organisms in check. For example, in the Mississippi River Delta area, barrier

islands, marshes, cypress trees, and tupelo swamp all provide storm buffering by reducing wave heights and by slowing and dispersing storm surges. Wetlands also provide waste treatment value and water quality improvements by absorbing nitrogen, phosphorus, and other drinking water contaminants. Many of these services are “non-market” services. Hurricane buffering, for example, is quite valuable and provided naturally by wetlands, but it is not sold in markets. Thus, non-market economic analysis is required in order to establish dollar values. For example, after Hurricane Rita, surveys of the debris lines on levees showed how much the wetlands between the levee and coast decreased wave action and storm surge. Reduced damages could be calculated to show the avoided cost provided by a wetland area for hurricane buffering.

3. ***Supporting services*** relate to the availability of refuge and reproductive habitat for wild plants and animals. To illustrate, the Mississippi Delta is one of the world’s great bird migration flyways, providing habitat for a multitude of species. In addition, the Delta helps maintain biological and genetic diversity. Habitat for many species has no calculated dollar value (such as that of a spicebush swallowtail butterfly); however, habitat for some wildlife may have a calculable dollar value. For instance, the Louisiana State insect, the honeybee, provides a supporting service in the pollination of crops and wild plants. The full value of that service cannot be easily monetized. While the value for pollinating Tabasco peppers on Avery Island can be monetized, the benefit of wildflower pollination and the enjoyment that people have from experiencing wildflowers requires non-monetary valuation.

4. ***Information services*** provide humans with meaningful interaction with nature. Louisiana is the “Sportsman’s Paradise.” There are over 300 recreational activities in Louisiana, including hiking, biking, swimming, bird watching, and vehicle-based recreation such as boating or all-terrain vehicle use. Information services also include spiritually significant species and places. This could include plants used for spiritual ceremonies by the Houma Tribe, for example. Culturally valuable attributes would include parks and historic sites, such as Fort Jackson. Natural systems also provide scientific and educational value. In the case of recreation, the dollar value of a recreational experience can be estimated monetarily by the costs of travel, lodging and food related to the recreational experience. Other values, such as spiritual value, have no dollar equivalent.

The publication of the MEA with its broad ecosystem service categories marked a landmark change in the view of ecosystem services and human well-being. For the purposes of categorizing gains and losses associated with the biophysical landscape changes expected in this analysis, this framework adopts a more detailed classification system first initiated by de Groot et al. 2002[42], further developed in the Millennium Ecosystem Assessment[43], and subsequently improved in The Economics of Ecosystems and Biodiversity (TEEB)[44]. In this classification system, each of the four broad categories has further sub-categories. Table 1 presents the 21 ecosystem goods and services that will be utilized.

Table 37. Typology for 21 Ecosystem Services[k]

Good/Service	Economic Benefit to People
Provisioning Services	
Food	Producing crops, fish, game, and fruits

[k] Source: Adapted from de Groot et al., 2002 and Sukhdev et al., 2010

Medicinal Resources	Providing traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Providing resources for clothing, jewelry, handicrafts, worship, and decoration
Energy and Raw Materials	Providing fuel, fiber, fertilizer, minerals, and energy
Water Storage	The quantity of water held by a water body (surface or ground water) and its capacity to provide water supply reliably.
Regulating Services	
Air Quality	Providing clean, breathable air
Biological Control	Providing pest and disease control
Climate Stability	Supporting a stable climate at global and local levels through carbon sequestration and other processes
Disaster Risk Reduction	Preventing and mitigating natural hazards such as floods, hurricanes, fires, and droughts
Pollination and Seed Dispersal	Pollination of wild and domestic plant species
Soil Formation	Creating soils for agricultural and ecosystems integrity; maintenance of soil fertility
Soil Quality	Improving soil quality by decomposing human and animal waste and removing pollutants
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Water Quality	Improving water quality by decomposing human and animal waste and removing pollutants
Water Capture, Conveyance, and Supply	Providing natural irrigation, drainage, groundwater recharge, river flows, drinking water supply, and water for industrial use.
Navigation	Maintaining water depth that meets draft requirements for recreational and commercial vessels
Supporting Services	
Habitat and Nursery	Maintaining genetic and biological diversity, the basis for most other ecosystem functions; promoting growth of commercially harvested species
Information Services	
Aesthetic Information	Enjoying and appreciating the presence, scenery, sounds, and smells of nature
Cultural Value	Using nature as motifs in art, film, folklore, books, cultural symbols, architecture, media, and for religious and spiritual purposes
Recreation and Tourism	Experiencing the natural world and enjoying outdoor activities
Science and Education	Using natural systems for education and scientific research

10.2. Description of Benefit Transfer Methodology

The BTM process identifies previously published service values from comparable ecosystems and 'transfers' them to a study site.[45] The process is similar to a home appraisal in which the value and features of comparable, neighboring homes (2-bedrooms, garage, 1 acre, recently remodeled) are used to estimate the value of the home in question. As with home appraisals, the BTM results can be somewhat rough, but quickly generate reasonable values appropriate for policy work and analysis.

The process begins by finding primary studies with comparable land cover classifications (wetland, forest, grassland, etc.) as compared with those in the study area. Any primary studies deemed to have incompatible assumptions or land cover types are excluded. Next, individual primary study values are adjusted and standardized for units of measure, inflation, and land cover classification to generate an "apples-to-apples" comparison.

Frequently, primary studies offer a range of values that reflect the uncertainty or breadth of features found in the research area. In recognition of this variability and uncertainty, both high and low dollars per acre values are reported for each value.

This valuation was done through a land cover analysis using Earth Economics' Ecosystem Valuation Toolkit (EVT), which is the largest and most comprehensive repository of published, peer-reviewed primary valuation studies in the world.[46] These studies each use techniques developed and vetted within environmental and natural resource economics communities over the last four decades. Table 38 provides descriptions of the most common primary valuation techniques.

Table 38. Primary Valuation Methodologies for Ecosystem Goods and Services

Method	Description
Market Value (M)	The value that an ecosystem good is sold for in a market.
Avoided Cost (AC)	The value of costs avoided that would have been incurred in the absence of particular ecosystem services. Example: The hurricane protection that is provided by barrier islands avoids property damages along coastlines.
Replacement Cost (RC)	The cost of replacing ecosystem services with man-made systems. Example: Natural water filtration is replaced with a costly man-made filtration plant.
Factor Income (FI)	The enhancement of income by ecosystem service provision. Example: Water quality improvements increase commercial fisheries catch and thereby also the incomes of fishermen.
Travel Cost (TC)	The cost of travel required to consume or enjoy ecosystem services. Travel costs can reflect the implied value of the service. Example: Recreational areas attract tourists. The value they place on that area must, at a minimum, be at least the price they were willing to pay to travel to it.
Hedonic Pricing (HP)	The reflection of service demand in the varying prices people will pay for associated goods. Example: Housing prices of properties in close proximity to recreational areas can be higher than those that are farther from these areas.
Contingent Valuation (CV)	The value for service demand elicited by posing hypothetical scenarios that involve some valuation of land use alternatives. Example: People would be willing to pay for increased wetland restoration, as expressed through surveys.
Group Valuation (GV)	Discourse-based contingent valuation, which is conducted by bringing together a group of stakeholders to discuss values in order to determine society's willingness to pay. Example: Government, citizen's groups, and businesses come together to determine the value of an area and the services it provides.

11. Appendix B. Annotated Bibliography

Bergstrom, J. C., Stoll, J. R., Titre, J. P., & Wright, V. L. 1990. Economic value of wetlands-based recreation. Ecological Economics 2(2): 129-147.

This study looks into the total economic value of recreational wetlands. An empirical study was done to quantify the total economic value of current recreational uses provided my coastal wetlands. The results estimated aggregate expenditures to be valued at approximately $118 million and aggregate consumer's surplus at approximately $27 million. Suggesting that wetlands-based recreation may have substantial economic impacts and net economic benefits.

Breaux, A., Farber, S., Day, J. 1995. Using natural coastal wetlands systems for wastewater treatment: an economic benefit analysis. Journal of Environmental Management 44(3): 285-291.

Coastal wetlands can be used as substitutes for traditional wastewater treatments. For this report an economic benefit analysis was done using coastal wetlands as replacement wastewater treatments in Louisiana. Estimates of discounted costs savings were found to range from $785-$3400 per acre of wetland used as a substitute for treatment. These results suggest that substituting wastewater treatment with coastal wetlands may have economic benefits.

Costanza, R., Farber, S. C., & Maxwell, J. 1989. Valuation and management of wetland ecosystems. Ecological Economics 1(4): 335-361.

A comprehensive study was done looking into the valuation and management of wetland ecosystems in Louisiana detailing the fundamental theoretical and practical problems underlying natural resource valuation as well as details the methodology and findings specific to Louisiana wetlands. Using both willingness-to-pay and analysis-based methodologies the report estimates the total value of an average acre of natural wetland in Louisiana to be $2429-6400 per acre (assuming a %8 discount rate) to $8977-17000 per acre (assuming a %3 discount rate). Additionally this paper elaborates on problems associated with applied natural resource valuation, including discounting and dealing with uncertainty and precision.

Costanza, R., O. Perez-Maqueo, M.L. Martinez, P. Sutton, S.J. Anderson, and K. Mulder. 2008. The value of coastal wetlands for hurricane protection. Ambio 37(4): 241-248.

Using a multiple step process an estimate was created for the value of coastal wetlands as hurricane protection. The first step was a multiple regression analysis using 34 hurricanes that have hit the US since 1980 with relative damages as the dependent variable and wind speed and wetland area as the independent variable. The second step used a version of the relationship derived from step 1 combined with data on annual hurricane frequency to derive estimates of the annual value of wetlands for storm protection. The annual value was estimated to range from $250 to $51000 ha^{-1} yr^{-1}, with a mean of $8240 $ha^{-1}yr^{-1}$.

Grabowski, J. H., Brumbaugh, R. D., Conrad, R. F., Keeler, A. G., Opaluch, J. J., Peterson, C. H., Piehler, M. F., Powers, S. P., Smyth, A. R. 2012. Economic Valuation of Ecosystem Services Provided by Oyster Reefs. American Institute of Biological Sciences. 62: 900-909.

An economic valuation of ecosystem services provided by oyster reefs is provided. While oyster reefs have long been appreciated only as a commercial source of oysters, they are now acknowledged for other services they provide such as enhancing water quality and stabilizing shorelines. A framework for assessing these values is developed and a conservative estimate of the economic value of oyster reef services, excluding oyster harvesting is said to be between $5500 and $99000 per hectare per year. It is also estimated that oyster reefs recover their median restoration costs in 2-14 years in there is no oyster harvesting.

Petrolia, D. R., Interis, M. G., Hidrue, M. K., Hwang, J., Moore, R. G., & Kim, G. 2012. America's Wetland? A National Survey of Willingness to Pay for Restoration of Louisiana's Coastal Wetlands. University of Chicago Press 29(1): 17-37.

This report details the findings of a survey done to estimate welfare associated with large-scale wetland restoration in coastal Louisiana. Binary and multi-choice service instruments were used to estimate a willingness to pay (WTP) for three ecosystem services: wildlife habitat provision, storm surge protection and fisheries productivity. Results found that all three ecosystems services impacted project support with fisheries productivity have the largest marginal impact followed by storm surge protection and then wildlife habitat provision. A mean household WTP in the form of a one-time tax was estimated to be $909, with resource users willing to pay substantially more.

Pollack, J. B., Yoskowitz, D., Kim, H., Montagna, P. A. 2013. Role and Value of Nitrogen Regulation Provided by Oysters (Crassostrea virginica) in the Mission-Aransas Estuary, Texas, USA. Public Library of Science. 8: 1-8.

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